Hong Kong Diploma of Secondary Education Examination

Physics – Compulsory part (必修部分)

Section A – Heat and Gases (熱和氣體)
1. Temperature, Heat and Internal energy (溫度、熱和內能)
2. Transfer Processes (熱轉移過程)
3. Change of State (形態的改變)
4. General Gas Law (普適氣體定律)
5. Kinetic Theory (分子運動論)

Section B – Force and Motion (力和運動)
1. Position and Movement (位置和移動)
2. Newton's Laws (牛頓定律)
3. Moment of Force (力矩)
4. Work, Energy and Power (作功、能量和功率)
5. Momentum (動量)
6. Projectile Motion (拋體運動)
7. Circular Motion (圓周運動)
8. Gravitation (引力)

Section C – Wave Motion (波動)
1. Wave Propagation (波的推進)
2. Wave Phenomena (波動現象)
3. Reflection and Refraction of Light (光的反射及折射)
4. Lenses (透鏡)
5. Wave Nature of Light (光的波動特性)
6. Sound (聲音)

Section D – Electricity and Magnetism (電和磁)
1. Electrostatics (靜電學)
2. Electric Circuits (電路)
3. Domestic Electricity (家居用電)
4. Magnetic Field (磁場)
5. Electromagnetic Induction (電磁感應)
6. Alternating Current (交流電)

Section E – Radioactivity and Nuclear Energy (放射現象和核能)
1. Radiation and Radioactivity (輻射和放射現象)
2. Atomic Model (原子模型)
3. Nuclear Energy (核能)

Physics – Elective part (選修部分)

Elective 1 – Astronomy and Space Science (天文學和航天科學)
1. The universe seen in different scales (不同空間標度下的宇宙面貌)
2. Astronomy through history (天文學的發展史)
3. Orbital motions under gravity (重力下的軌道運動)
4. Stars and the universe (恒星和宇宙)

Elective 2 – Atomic World (原子世界)
1. Rutherford's atomic model (盧瑟福原子模型)
2. Photoelectric effect (光電效應)
3. Bohr's atomic model of hydrogen (玻爾的氫原子模型)
4. Particles or waves (粒子或波)
5. Probing into nano scale (窺探納米世界)

Elective 3 – Energy and Use of Energy (能量和能源的使用)
1. Electricity at home (家居用電)
2. Energy efficiency in building (建築的能源效率)
3. Energy efficiency in transportation (運輸業的能源效率)
4. Non-renewable energy sources (不可再生能源)
5. Renewable energy sources (可再生能源)

Elective 4 – Medical Physics (醫學物理學)
1. Making sense of the eye (眼的感官)
2. Making sense of the ear (耳的感官)
3. Medical imaging using non-ionizing radiation (非電離輻射醫學影像學)
4. Medical imaging using ionizing radiation (電離輻射醫學影像學)

DSE Physics - Section A : M.C.
HG3 : Change of State

PA - HG3 - M / 01

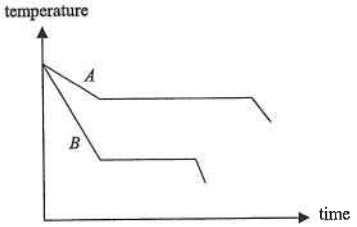
The following list of formulae may be found useful :

Energy transfer during heating or cooling $E = m c \Delta T$

Energy transfer during change of state $E = l \Delta m$

Part A : HKCE examination questions

1. < HKCE 1980 Paper II - 14 >



Two liquids A and B are cooled in air. Their cooling curves are shown. If A and B have the same mass, which of the following statements is/are true ?

(1) A has a higher freezing point than B.

(2) A has a greater specific latent heat of fusion than B.

(3) Liquid A has a greater specific heat capacity than liquid B.

A. (3) only
B. (1) & (2) only
C. (2) & (3) only
D. (1), (2) & (3)

2. < HKCE 1981 Paper II - 10 >

A liquid placed inside an insulated vessel is kept boiling by a heating coil immersed in it. When the power supplied to the coil is 42 W, the liquid boils away at a rate of 10^{-4} kg s^{-1}. What is the specific latent heat of vaporization of the liquid ?

A. 42×10^3 J kg^{-1}
B. 21×10^4 J kg^{-1}
C. 42×10^4 J kg^{-1}
D. 21×10^5 J kg^{-1}

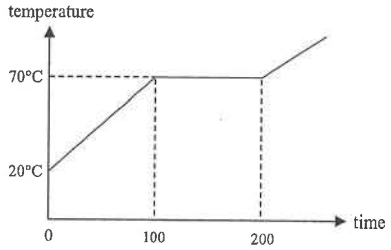
3. < HKCE 1981 Paper II - 13 >

0.10 g of steam at 100°C is mixed with 0.10 g of ice at 0°C. No heat is lost to the surroundings. Which of the following describes the final mixture ?

Given : specific heat capacity of water = 4.2 kJ kg^{-1} $°C^{-1}$
specific latent heat of ice = 336 kJ kg^{-1}
specific latent heat of steam = 2260 kJ kg^{-1}

A. A mixture of water and steam at 100°C
B. Water at 0°C
C. Water at 50°C
D. Water at 100°C

4. **< HKCE 1982 Paper II - 10 >**



A solid substance of mass 2 kg and specific heat capacity 1000 J kg^{-1} $°C^{-1}$ is heated uniformly by a constant heat source. The temperature-time graph of the substance is shown in the graph. Assuming that no heat is lost, find from the graph the specific latent heat of fusion of the substance.

A. 1000 J kg^{-1}
B. 20000 J kg^{-1}
C. 30000 J kg^{-1}
D. 50000 J kg^{-1}

5. **< HKCE 1982 Paper II - 22 >**

The following data shows the thermal properties of four substances *P*, *Q*, *R* and *S* :

Substance	***P***	***Q***	***R***	***S***
Melting point	40 K	98 K	114 K	270 K
Boiling point	280 K	880 K	180 K	370 K
Average specific heat capacity in J kg^{-1} $°C^{-1}$	800	1200	226	40
Specific latent heat of fusion in J kg^{-1}	2×10^4	11×10^4	5×10^4	33×10^4
Specific latent heat of vaporization in J kg^{-1}	30×10^4	34×10^4	40×10^4	230×10^4

When the temperature of each substance is increased from 250 K to 400 K, which one will absorb the greatest amount of energy ?

A. *P*
B. *Q*
C. *R*
D. *S*

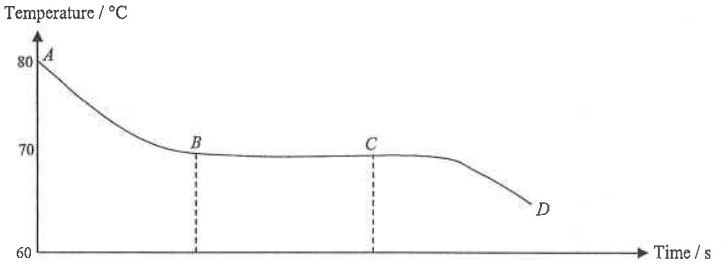
6. **< HKCE 1983 Paper II - 15 >**

It is given that : the specific latent heat of fusion of ice = 3.3×10^5 J kg^{-1}
the specific latent heat of vaporization of water = 2.3×10^6 J kg^{-1}

If 1 kg of ice at 0°C and 1 kg of steam at 100°C are mixed in a well insulated vessel, the result will be

A. a mixture of ice and ice-cold water.
B. a mixture of steam and boiling water.
C. water at 0°C.
D. water at 50°C.

7. **< HKCE 1984 Paper II - 11 >**



A cooling curve for liquid naphthalene is shown above. From the graph, which of the following statement(s) is/are true ?

(1) The melting point of naphthalene is around 70°C.
(2) In the period *BC*, only liquid naphthalene is present.
(3) In the period *BC*, no energy is given by naphthalene to the surroundings.

A. (1) only
B. (1) & (2) only
C. (1) & (3) only
D. (2) & (3) only

8. **< HKCE 1984 Paper II - 10 >**

If an immersion heater takes 10 minutes to bring a cup of water to its boiling point 100°C from the room temperature of 20°C, what will be the time taken for the boiling water to vaporize completely ?
(Specific heat capacity of water = 4.2 kJ kg^{-1} $°C^{-1}$; specific latent heat of steam = 2268 kJ kg^{-1}.)

A. 33.75 minutes
B. 54.00 minutes
C. 67.50 minutes
D. 75.40 minutes

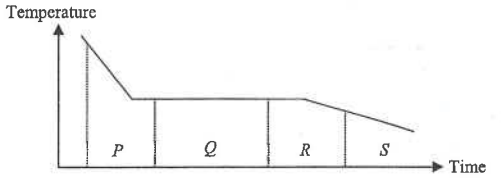
9. **< HKCE 1985 Paper II - 13 >**

Heat is needed to keep water boiling because energy is required to

(1) increase the potential energy of the water molecules.
(2) increase the kinetic energy of the water molecules.
(3) increase the average speed of the water molecules.

A. (1) only
B. (1) & (2) only
C. (1) & (3) only
D. (2) & (3) only

10. **< HKCE 1986 Paper II - 21 >**



The graph shows the cooling curve of liquid naphthalene. In which region has naphthalene completely solidified ?

A. *P*
B. *Q*
C. *R*
D. *S*

11. **< HKCE 1987 Paper II - 26 >**

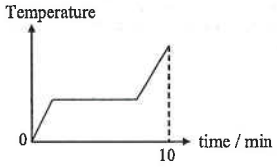
Arrange the following in ascending order.

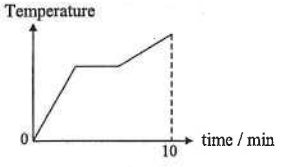
E_1 = Energy required to melt 1 kg of ice at 0°C
E_2 = Energy required to raise the temperature of 1 kg of copper by 1°C
E_3 = Energy required to vaporize 1 kg of water at 100°C
E_4 = Energy required to raise the temperature of 1 kg of water by 1°C

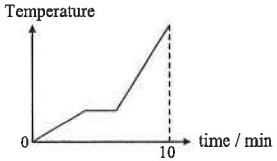
A. $E_2 < E_4 < E_1 < E_3$
B. $E_2 < E_4 < E_3 < E_1$
C. $E_3 < E_1 < E_4 < E_2$
D. $E_4 < E_2 < E_3 < E_1$

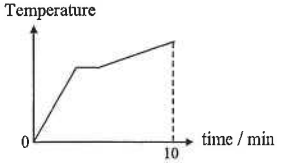
12. **< HKCE 1988 Paper II - 11 >**

Five different solids, each of mass 1 kg, are heated by identical immersion heaters for 10 minutes. The following graphs show their heating curves. Assuming no loss in heat, which solid has the greatest specific latent heat of fusion ?

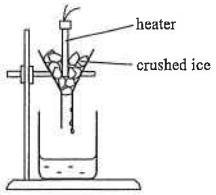
A.


B.


C.


D.


13. **< HKCE 1989 Paper II - 18 >**



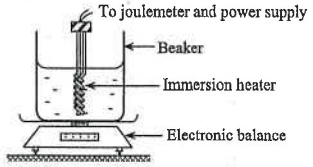
The figure shows an experiment to determine the specific latent heat of fusion of ice. The result obtained is lower than the one expected. The main reason could be that

A. there is heat gain from the surroundings.
B. there is heat loss to the surroundings.
C. there is some water remaining in the funnel, not falling into the beaker.
D. the temperature of ice is below 0°C.

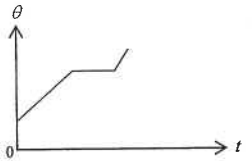
14. **< HKCE 1990 Paper II - 21 >**

The apparatus shown is used to find the specific latent heat of vaporization of water. Which of the following is NOT correct ?

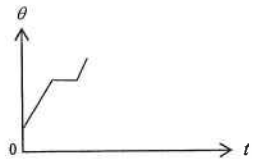
A. Cover the beaker with a lid.
B. Use a suitable heater to prevent boiling the water too vigorously.
C. Surround the beaker with some cotton.
D. Repeat the experiment several times and take the mean of the results.

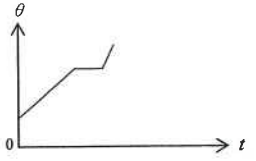


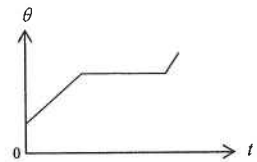
15. **< HKCE 1990 Paper II - 22 >**

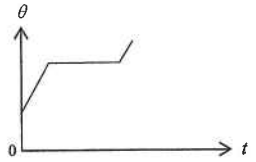


A 20 W heater is used to melt a solid. A graph of temperature θ against time t is plotted as shown above. If a heater of 40 W is used, which graph (using the same scale) would be obtained ?

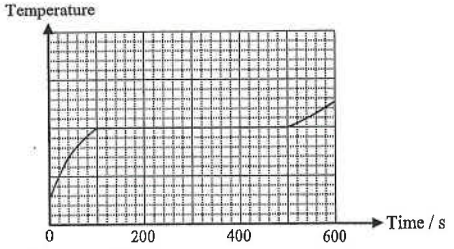
A.


B.


C.


D.


16. **< HKCE 1991 Paper II - 18 >**



A 400 W electric heater is used to heat 0.4 kg of a solid. The graph shows the temperature against time of the substance. The specific latent heat of fusion of the substance is

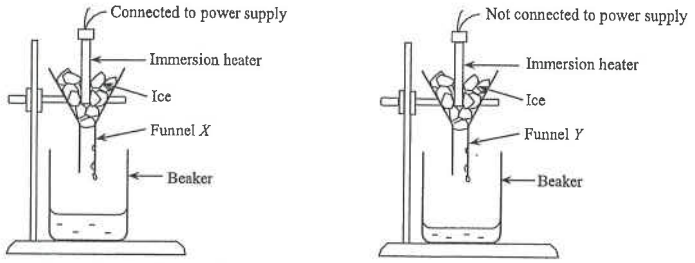
A. 64 kJ kg^{-1}
B. 160 kJ kg^{-1}
C. 400 kJ kg^{-1}
D. 500 kJ kg^{-1}

17. **< HKCE 1992 Paper II - 17 >**

An immersion heater is used to heat a cup of water. It takes 10 minutes to bring the water from 20°C to its boiling point 100°C. Find the time taken for the heater to vaporize the boiling water completely.
(Given : specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$
specific latent heat of vaporization of water = 2.268×10^6 J kg^{-1}.)

A. 54 minutes
B. 60 minutes
C. 67.5 minutes
D. 77.5 minutes

18. **< HKCE 1994 Paper II - 17 >**



The above apparatus is used to find the specific latent heat of fusion of ice. Which of the following is an essential precaution to ensure an accurate result ?

A. Crushed ice should be used.
B. The ice used should be just taken from the refrigerator so that its temperature is well below 0°C.
C. The amount of ice used in funnel *X* should be larger than that in *Y*.
D. The two funnels should be wrapped in insulating material.

19. **< HKCE 1995 Paper II - 19 >**

Which of the following substances is a liquid at room temperature (about 20°C) ?

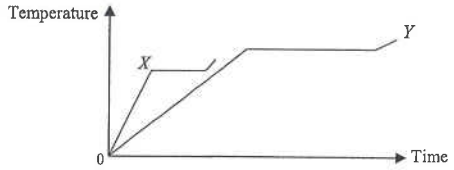
	Substance	Melting point / °C	Boiling point / °C
A.	*P*	25	444
B.	*Q*	–39	357
C.	*R*	44	280
D.	*S*	–218	–183

20. **< HKCE 1995 Paper II - 22 >**

The melting point of copper is 1080°C and its specific latent heat of fusion is 2.1×10^5 J kg^{-1}. How much energy is needed to melt 0.5 kg of copper at its melting point ?

A. $2.1 \times 10^5 / 0.5$ J
B. $0.5 \times 2.1 \times 10^5$ J
C. $2.1 \times 10^5 / (0.5 \times 1080)$ J
D. $0.5 \times 2.1 \times 10^5 / 1080$ J

21. **< HKCE 1996 Paper II - 21 >**

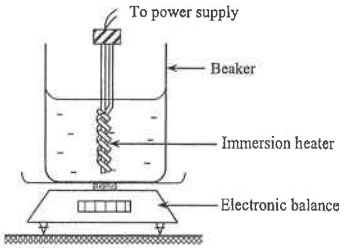


Two solid substances *X* and *Y* of equal mass are separately heated by two identical heaters. The above figure shows the variation of the temperatures of the substances with time. Which of the following statements is/are correct ?

(1) The melting point of *X* is higher than that of *Y*.
(2) The specific heat capacity of *X* is smaller than that of *Y*.
(3) The specific latent heat of fusion of *X* is smaller than that of *Y*.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

Questions 22 and 23 : The following apparatus is used to find the specific latent heat of vaporization of a liquid.



22. **< HKCE 1996 Paper II - 19 >**

When the liquid boils, the reading of the balance is taken. After 200 s, the reading of the balance decreases by 0.02 kg. The power output of the heater is 150 W. If 20% of the energy supplied is lost to the surroundings, find the specific latent heat of vaporization of the liquid.

A. 120 J kg^{-1}
B. 480 J kg^{-1}
C. 3.0×10^5 J kg^{-1}
D. 1.2×10^6 J kg^{-1}

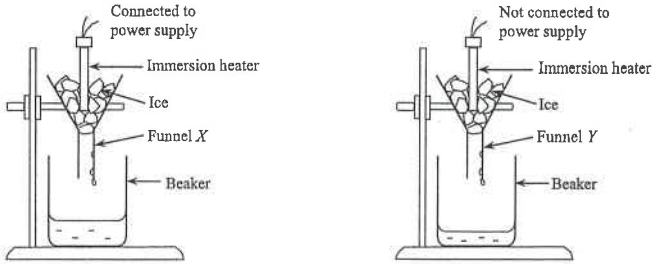
23. **< HKCE 1996 Paper II - 20 >**

Which of the following can improve the accuracy of the experiment ?

(1) covering the beaker with a lid
(2) completely immersing the heating coil in liquid
(3) stirring the liquid throughout the experiment

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

24. **< HKCE 1998 Paper II - 20 >**



The above set-up can be used to find the specific latent heat of fusion of ice. Which of the following is **not** an essential precaution to ensure an accurate result ?

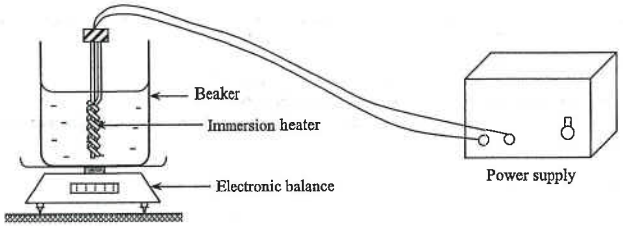
A. covering the funnels with lids
B. using melting ice in the experiment
C. inserting the immersion heater into the ice completely
D. using the same amount of ice in both funnels

25. **< HKCE 1998 Paper II - 22 >**

A block of melting ice with mass 0.02 kg is put into a polystyrene cup containing 0.3 kg of water with initial temperature 20°C. After the mixture is stirred well, the ice block melts completely and the final temperature of the water becomes 14°C. Which of the following equations can be used to find the specific latent heat of fusion of ice, L ?
(Given : Specific heat capacity of water = 4200 J kg^{-1} °C^{-1})

A. $0.3 \times 4200 \times 6 = 0.02\,L + 0.02 \times 4200 \times 14$
B. $0.3 \times 4200 \times 6 = 0.02\,L - 0.02 \times 4200 \times 6$
C. $0.3 \times 4200 \times 6 = 0.02\,L + 0.02 \times 4200 \times 6$
D. $0.3 \times 4200 \times 6 = (0.02\,L + 0.02 \times 4200) \times 14$

26. **< HKCE 1999 Paper II - 17 >**



The above apparatus is used to find the specific latent heat of vaporization of a liquid. Which of the following can improve the accuracy of the experiment ?

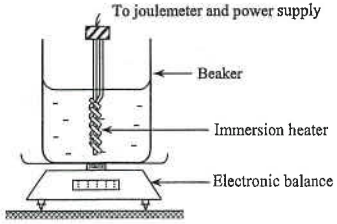
A. Wrapping the beaker with cotton wool
B. Covering the beaker with a lid
C. Stirring the liquid throughout the experiment
D. Using shorter wires to connect the heater and the power supply

27. **< HKCE 2000 Paper II - 18 >**

A cup of fruit juice is of mass 0.2 kg and temperature 70°C. If the specific heat capacity of the fruit juice is 4000 J kg^{-1} °C^{-1}, find the minimum amount of ice at 0°C that should be added to the juice in order to lower its temperature to 0°C.
(Note : Specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}.)

A. 0.17 kg
B. 0.20 kg
C. 0.37 kg
D. 0.84 kg

28. **< HKCE 2000 Paper II - 21 >**



The above apparatus is used to find the specific latent heat of vaporization of water l_v. Which of the following factors will cause the result obtained to be larger than the true value of l_v ?

(1) Some energy is lost to the surroundings.
(2) Some steam condenses and drips back into the beaker.
(3) Some boiling water inside the beaker splashes out of the beaker.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

29. **< HKCE 2001 Paper II - 16 >**

A melting ice block of mass 0.05 kg is mixed with x kg of water at 0°C in a well-insulated container. If 25 000 J of energy is supplied to the mixture, the mixture changes to water at 4°C. Find the value of x.
(Given : specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}, specific heat capacity of water = 4200 J kg^{-1} °C^{-1}.)

A. 0.37
B. 0.44
C. 0.49
D. 1.44

30. **< HKCE 2001 Paper II - 30 >**

A cup of liquid P and a cup of liquid Q of equal mass are heated at the same rate. It is found that the temperature of P is rising at a rate faster than that of Q.
Which of the following deductions is/are correct ?

(1) P has a lower specific latent heat of vaporization than Q.
(2) P has a lower boiling point than Q.
(3) P has a lower specific heat capacity than Q.

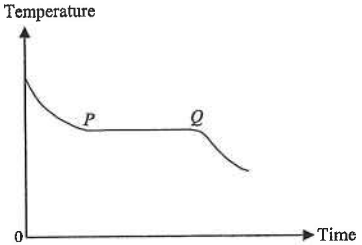
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

31. **< HKCE 2001 Paper II - 18 >**

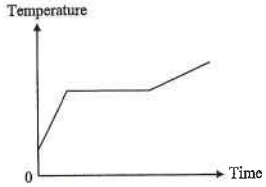
The figure shows the cooling curve of a substance which is initially in the liquid state. The temperature of the substance remains unchanged during the period PQ. Which of the following statements about the substance during the period PQ is/are correct ?

(1) The substance is **not** losing any energy to the surroundings.
(2) Latent heat is absorbed by the substance.
(3) The average potential energy of the molecules of the substance is decreasing.

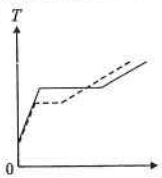
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

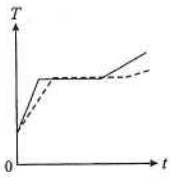


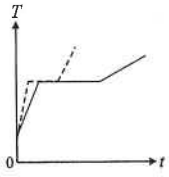
32. **< HKCE 2002 Paper II - 19 >**

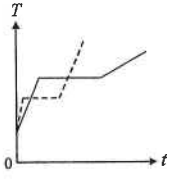


A certain amount of crushed solid is heated and the variation of its temperature T with time t is shown above. If the same heater is used to heat a smaller amount of the solid, which of the following graphs (in dash lines) best shows the variation of the temperature of the solid ?

A. 

B. 

C. 

D. 

33. **< HKCE 2003 Paper II - 21 >**

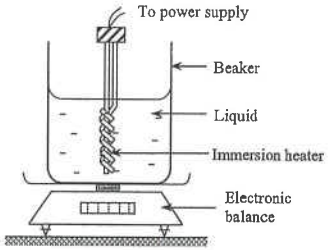


Figure (a)

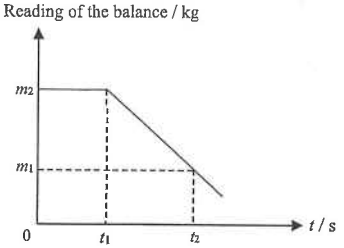
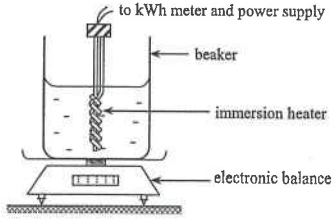


Figure (b)

As shown in Figure (a), some liquid in a beaker is heated by a 1000 W immersion heater. Figure (b) shows the variation of the reading of the electronic balance with time t. Which of the following statements about the liquid is **incorrect** ?

A. It starts to boil at $t = t_1$.
B. Its temperature increases during the period $t = 0$ to t_1.
C. Its specific heat capacity can be estimated by $\frac{1000t_1}{m_2}$.
D. Its specific latent heat of vaporization can be estimated by $\frac{1000(t_2 - t_1)}{m_2 - m_1}$.

Questions 34 and 35 : The following set-up is used to measure ℓ_v, the specific latent heat of vaporization of a liquid.



34. **< HKCE 2004 Paper II - 19 >**

The result of the experiment is as follows:
Initial reading of the balance = 1.60 kg Final reading of the balance = 1.45 kg
Energy supplied as measured by the kWh meter = 0.10 kWh
Find the measured value of ℓ_v.

A. 2.25×10^5 J kg^{-1}
B. 2.48×10^5 J kg^{-1}
C. 2.40×10^6 J kg^{-1}
D. 6.67×10^6 J kg^{-1}

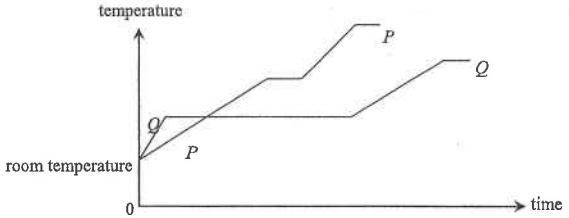
35. **< HKCE 2004 Paper II - 20 >**

How will the value of ℓ_v obtained in the experiment be affected if the following measures are taken separately ?

I. replacing the beaker with a polystyrene container which is a better insulator
II. adding more liquid into the beaker until the heater is completely immersed

	I	II
A.	decreases	increases
B.	decreases	decreases
C.	increases	increases
D.	increases	decreases

36. **< HKCE 2004 Paper II - 18 >**



The graph shows the variation in temperature of equal masses of two substances P and Q when they are separately heated by identical heaters. Which of the following deductions is correct ?

A. The melting point of P is lower than that of Q.
B. The specific heat capacity of P in solid state is larger than that of Q.
C. The specific latent heat of fusion of P is larger than that of Q
D. The energy required to raise the temperature of P from room temperature to boiling point is more than that of Q.

37. **< HKCE 2005 Paper II - 9 >**

Figure (a)

Figure (b)

When Joanne gets off from an air-conditioned bus in the summer, her glasses become misty (see Figure (a)). After a while, the glasses become clear again (see Figure (b)). Which of the following physical processes are involved in the above phenomena ?

A. condensation followed by evaporation
B. condensation followed by fusion
C. solidification followed by evaporation
D. solidification followed by fusion

38. **< HKCE 2005 Paper II - 33 >**

If equal masses of boiling water and melting ice cubes are mixed, which of the following best describes the state of the mixture ? (Specific heat capacity of water = 4200 J kg^{-1} °C^{-1} ; Specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1})

A. water at 0°C
B. water at a temperature higher than 0°C
C. a mixture of water and ice at 0°C
D. It cannot be determined since the masses of the water and ice are not given.

39. **< HKCE 2006 Paper II - 10 >**

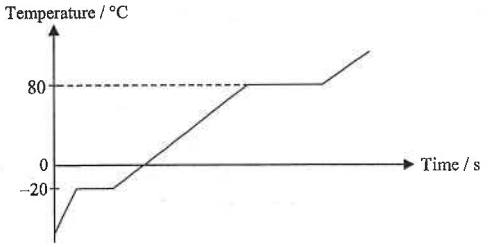
A space shuttle is covered by 'heat shields' over its body so as to protect the interior from getting too hot while entering the atmosphere of the Earth. Which of the following thermal properties is/are desirable for the material of the 'heat shields' ?

(1) It should be a good conductor of heat.
(2) It should have a very high melting point.
(3) It should have high specific heat capacity.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

40. **< HKCE 2006 Paper II - 11 >**

A substance X is heated at a constant rate and its changing temperature over a time period is recorded. The data are plotted below.



Which of the following statements about the substance X is **incorrect** ?

A. X is in liquid state at 0°C.
B. The boiling point of X is 80°C.
C. The specific heat capacity of X in the solid state is smaller than that of X in the gas state.
D. The specific latent heat of fusion of X is larger than the specific latent heat of vaporization of X.

41. **< HKCE 2006 Paper II - 12 >**

The initial temperature of a jar of juice is 80°C and the mass of the juice is 2 kg. Susan adds ice cubes into the jar in order to cool down the juice to 20°C. What is the minimum number of ice cubes at 0°C required ?

(Neglect the heat capacity of the jar and assume there is no heat exchange with the surroundings.)

Given : Mass of each ice cube = 0.15 kg
Specific heat capacity of juice = 4700 J kg^{-1} °C^{-1}
Specific heat capacity of water = 4200 J kg^{-1} °C^{-1}
Specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}

A. 9
B. 10
C. 11
D. 12

42. **< HKCE 2007 Paper II - 7 >**

Water has a very high value of specific latent heat of vaporization. Which of the following statements can be illustrated by this fact ?

(1) Water is used as the coolant in car engines.
(2) Coastal region has milder climate as comparing with inland region.
(3) Steam at 100°C causes more serious injury to skin than boiling water.

A. (1) only
B. (2) only
C. (3) only
D. (1), (2) & (3)

43. **< HKCE 2007 Paper II - 34 >**

Which of the following statements about evaporation are correct ?

(1) Evaporation occurs only on the surface of the liquid.
(2) The rate of evaporation is higher when the temperature is higher.
(3) After evaporation, the average kinetic energy of the remaining liquid molecules will increase.

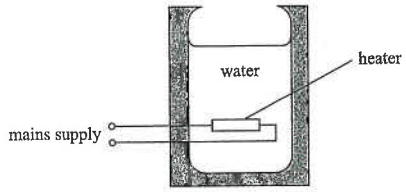
A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

44. **< HKCE 2007 Paper II - 8 >**

In an experiment, 2 kg of water at 20°C is heated inside a boiler for 20 minutes. Water is boiled to 100°C and 1.7 kg of water remains after boiling. What is the estimated power of the boiler ?

Given : Specific heat capacity of water = 4200 J kg^{-1} °C^{-1}
Specific latent heat of vaporization = 2.26×10^6 J kg^{-1}

A. 565 W
B. 649 W
C. 1125 W
D. 3762 W



45. **< HKCE 2008 Paper II - 34 >**

Which of the following has the highest average speed of the molecules ?

A. 1 g of ice cube at −10°C
B. 10 g of melting ice cube
C. 100 g of water at room temperature
D. 0.1 g of steam at 100°C

46. **< HKCE 2008 Paper II - 11 >**

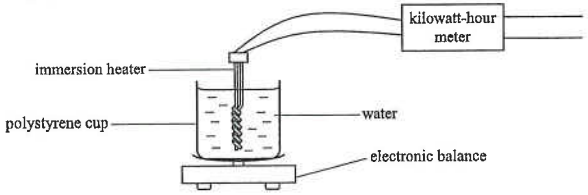
Which of the following statements is/are correct ?

(1) Energy transfers from an object with higher internal energy to an object with lower internal energy.
(2) An object must absorb energy when it changes its state.
(3) Energy transfers from an object with higher temperature to an object with lower temperature.

A. **(2)** only
B. **(3)** only
C. **(1)** & (2) only
D. **(1)** & (3) only

47. **< HKCE 2009 Paper II - 12 >**

In an experiment, a kilowatt-hour meter is used to measure the energy supplied to an immersion heater. An electronic balance is used to measure the change of the mass. The data obtained is used to estimate the specific latent heat of vaporization of water (l).



If the following experimental error arise :

(I) Water splashes out of the polystyrene cup as the boiling is too vigorous.

(II) Water vapour condenses on the upper part of the heater and drips back into the polystyrene cup.

How would the calculated value of l be affected ?

	(I)	(II)
A.	increases	decreases
B.	increases	increases
C.	decreases	decreases
D.	decreases	increases

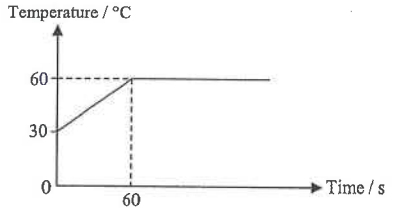
48. **< HKCE 2009 Paper II - 10 >**

Some ice cubes at 0°C are added to 0.3 kg of soft drink at 20°C. What is the minimum amount of ice needed to cool the soft drink to 0°C ?

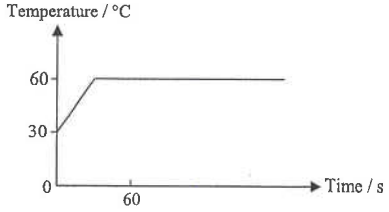
Given : specific heat capacity of the soft drink = 5300 J kg^{-1} °C^{-1}
specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}

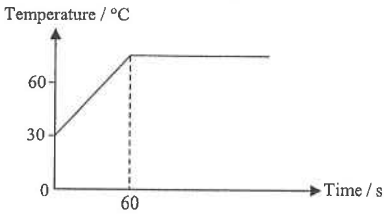
A. 0.08 kg
B. 0.10 kg
C. 0.26 kg
D. 0.32 kg

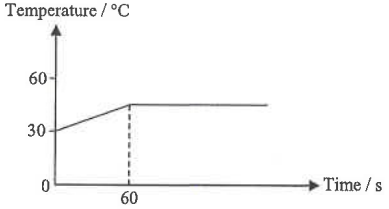
49. **< HKCE 2009 Paper II - 11 >**

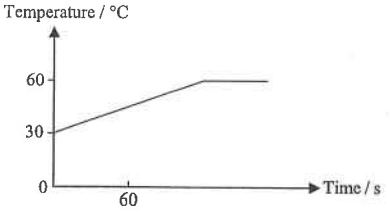


When a certain mass of a solid substance is heated by a heater of constant power, the variation of its temperature with time is shown in the figure above. If a greater mass of the same substance is heated by the same heater, which of the following graphs best represents how its temperature varies with time ? (Assume no heat lost to the surroundings.)

A.


B.


C.


D.


50. **< HKCE 2010 Paper II - 8 >**

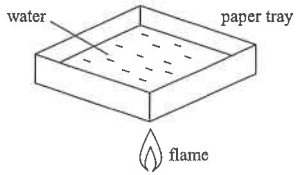
Three different solids, initially at 20°C, are heated at the same power.

solid	heat capacity / J °C^{-1}	melting point / °C
P	300	218
Q	500	132
R	900	84

Which solid will start melting first ?

A. *P*
B. *Q*
C. *R*
D. cannot be determined as the mass is unknown

51. **< HKCE 2010 Paper II - 9 >**



A paper tray contains some water. The tray is heated by a gentle flame from below as shown. The water in the tray starts to boil while the paper does not catch fire. Which of the following statements are correct in this situation ?

(1) Water can transfer heat away from the paper tray very quickly.
(2) Water remains at 100°C when it is boiling.
(3) There is no heat transfer between the paper tray and the flame.

A. (1) & (2) only
B. (2) & (3) only
C. (1) & (3) only
D. (1), (2) & (3)

52. **< HKCE 2010 Paper II - 11 >**

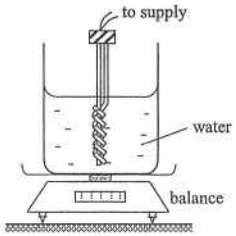


Figure (a)

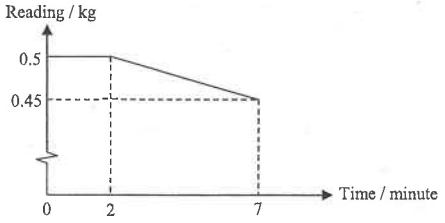


Figure (b)

Figure (a) shows a beaker of water heated by an immersion heater. Figure (b) shows the variation of the reading of the balance with time. What is the estimated output power of the heater ?
(Assume no heat lost to the surroundings.)

Given : specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}
specific heat capacity of water = 4200 J kg^{-1} °C^{-1}

A. 175 W
B. 269 W
C. 377 W
D. 700 W

53. **< HKCE 2010 Paper II - 10 >**

People feel cooler when they get out of water after swimming. Which of the following is/are the reason(s) ?

(1) The water on the skin evaporates.
(2) The water on the skin absorbs latent heat of fusion.
(3) The water on the skin releases latent heat of vaporization to the surrounding air.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

Questions 54 and 55 :

The setup in Figure (a) is used to determine the specific latent heat of fusion of ice. At time $t = 0$, 0.15 kg of ice cubes at 0°C are added into 1 kg of hot water. The initial temperature of water is 60°C. Figure (b) shows the variation of the water temperature with time. At Q, the mixture achieves the thermal equilibrium.

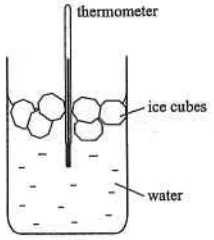


Figure (a)

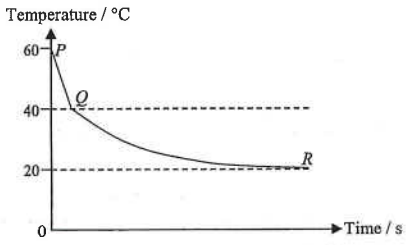


Figure (b)

54. **< HKCE 2011 Paper II - 9 >**

What is the specific latent heat of fusion of ice estimated from this experiment ?
Given : specific heat capacity of water = 4200 J kg^{-1} °C^{-1} ?

A. 3.34×10^5 J kg^{-1}
B. 3.92×10^5 J kg^{-1}
C. 4.48×10^5 J kg^{-1}
D. 5.60×10^5 J kg^{-1}

55. **< HKCE 2011 Paper II - 10 >**

Which of the following statements about the experiment is correct ?

A. Between P and Q, the water is absorbing latent heat of fusion from the ice.
B. Between P and Q, the temperature of the ice is increasing.
C. Between Q and R, the water is absorbing energy from the surroundings.
D. The temperature of the surroundings is 20°C.

Part B : Supplemental exercise

56. An ice-making machine extracts energy at a rate of 500 W. The specific latent heat of fusion of ice is 334 kJ kg^{-1}. How long does it take to change 10 kg of water at 0°C to become ice at 0°C ?

A. $\frac{10 \times 334}{500}$ s
B. $\frac{10 \times 500}{334}$ s
C. $\frac{10 \times 334 \times 1000}{500}$ s
D. $\frac{10 \times 500}{334 \times 1000}$ s

57. An immersion heater rated at 150 W is fitted into a large block of ice at 0°C. How long does it take to melt 30 g of ice ?
(Given : Specific latent heat of fusion of ice is 334 000 J kg^{-1}.)

A. 33.4 seconds
B. 66.8 seconds
C. 66800 seconds
D. 66.8 minutes

58. Which of the following statements correctly describe the difference between evaporation and boiling of a liquid ?

(1) Evaporation occurs at all temperatures but boiling occurs at one temperature only.
(2) Evaporation occurs at surface of the liquid but boiling occurs throughout the liquid.
(3) Evaporation does not absorb latent heat of vaporization but boiling absorbs latent heat of vaporization.

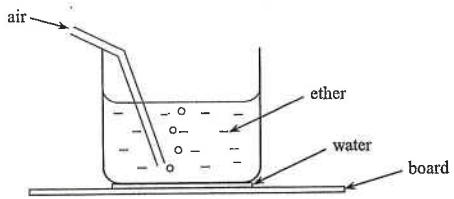
A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

59. Which of the following would enable wet clothes to dry more quickly ?

(1) Spread the clothes to increase the surface area.
(2) Increase the temperature of the environment.
(3) Blow air over the clothes.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

60.



The above diagram shows a beaker containing ether which is a volatile liquid. The beaker stands on a wooden board. A thin film of water is put between the board and the base of the beaker. Air is then blown through the tube so that it bubbles out from the immersed end. Which of the following would happen ?

(1) Ether evaporates from the beaker.
(2) Mist forms at the outer surface of the beaker.
(3) The water cools down and freezes.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

61. David sweats 0.1 kg of water in 10 minutes after the athlete meet. What is the rate of cooling of his body by sweating ?
(Specific latent heat of vaporization of water is 2.26×10^6 J kg^{-1})

A. 377 J s^{-1}
B. 754 J s^{-1}
C. 22600 J s^{-1}
D. 37700 J s^{-1}

62. In a refrigerator, the liquid Freon is pumped around the pipes in a circuit. Which of the following are correct ?

(1) As the Freon evaporates, it removes energy from the food.
(2) As the Freon condenses, it gives out energy.
(3) The energy removed from the food is given out at the back of the refrigerator.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

63. A cup of water is placed at the room temperature of 25°C. At which temperatures would evaporation and boiling start to occur respectively ?

	Temperature at which evaporation starts	Temperature at which boiling starts
A.	25°C	50°C
B.	25°C	100°C
C.	50°C	50°C
D.	100°C	100°C

64. When a liquid evaporates, some of the molecules escape from the surface and the temperature of the liquid change. Which of the following best describes the energy of the escaping molecules and the change in temperature of the liquid ?

	Energy of escaping molecules	Temperature of the liquid
A.	low	increase
B.	low	decrease
C.	high	increase
D.	high	decrease

65. The melting points and boiling points of four elements are listed below. Which element is a liquid at 1000°C ?

	Element	Melting point / °C	Boiling point / °C
A.	Aluminium	660	2470
B.	Mercury	– 39	357
C.	Chlorine	– 101	– 35
D.	Iron	1540	2750

66. When Paul goes out from an air-conditioned shopping mall, he found that his glasses become misted-up. Which of the following statements are correct ?

(1) Water vapour condenses onto the glass surfaces.
(2) Cold air holds less water vapour than warm air.
(3) Latent heat of vaporization is absorbed when mist is formed.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

67. If we come out from a swimming pool and do not dry ourselves, we would feel cool. What is the main reason ?

A. Water is a good conductor of heat.
B. Water is colder than the air.
C. Water has a high specific heat capacity.
D. Water evaporates in air.

68. What is the process that causes water molecules to escape from the surface of the sea to the sky ?

A. boiling
B. convection
C. evaporation
D. radiation

69. When water is heated steadily, its temperature stops to rise when the water starts to

A. release water vapour
B. evaporate.
C. freeze.
D. boil.

70. Mary hangs the wet clothes in a room for drying. Which of the following can help the clothes to dry more quickly ?

(1) Close the window.
(2) Switch on the dehumidifier.
(3) Switch on the heating radiator.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

71. Peter puts a few drops of alcohol in his right hand and a few drops of water in his left hand at the same time. He feels that his right hand is cooler than his left hand. Which of the following may be the reason ?

(1) Alcohol has evaporation but water does not have evaporation.
(2) The heat conduction of alcohol is better than that of water.
(3) Alcohol has a greater rate of evaporation than water.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

72. Which of the following statements are correct when a liquid is boiling ?

(1) When the liquid is boiling, large amounts of energy are absorbed.
(2) The average kinetic energy of its molecules is increased during boiling.
(3) The average potential energy of its molecules is increased during boiling.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

73. When a gas is heated, which of the following statements must be correct ?

(1) The temperature of the gas must increase.
(2) The kinetic energy of the gas molecules must increase.
(3) The molecules of the gas must move faster.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

74. Which of the following statements is/are correct when a vapour condenses into a liquid at its boiling point ?

(1) When the vapour condenses, its temperature decreases.
(2) The vapour releases energy to the surroundings during condensation.
(3) The average potential energy of the molecules decreases.

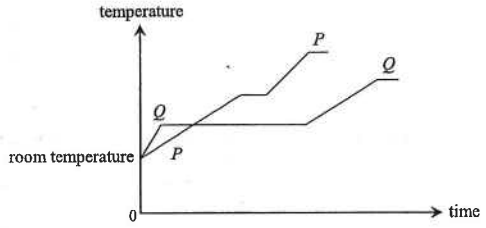
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

75. When a body is heated, which of the following statements must be correct ?

A. The internal energy of the body always increases.
B. The temperature of the body always increases.
C. The average kinetic energy of the molecules in the body always increases.
D. The average potential energy of the molecules in the body always increases.

Part C : HKDSE examination questions

76. < HKDSE Sample Paper IA - 2 >



The graph shows the variation in temperature of equal masses of two substances P and Q when they are separately heated by identical heaters. Which deduction is correct ?

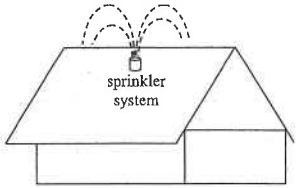
A. The melting point of P is lower than that of Q.

B. The specific heat capacity of P in solid state is larger than that of Q.

C. The specific latent heat of fusion of P is larger than that of Q

D. The energy required to raise the temperature of P from room temperature to boiling point is more than that of Q.

77. < HKDSE Practice Paper IA - 4 >



The sprinkler system on a rooftop is able to spray small water droplets onto the rooftop which can lower the temperature of the rooftop on hot sunny days. Which of the following explanations about the sprinkler system is/are reasonable ?

(1) Water is a good conductor, which conducts heat quickly.

(2) Water has a high specific heat capacity, absorbing a lot of energy when its temperature rises.

(3) Water has a high specific latent heat of vaporization, absorbing a lot of energy when it evaporates.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

78. < HKDSE 2012 Paper IA - 4 >

Which of the following descriptions is correct ?

A. When water at 25°C is heated to 50°C, both the kinetic energy and potential energy of the water molecules increase.

B. When water at 25°C is heated to 50°C, only the potential energy of the water molecules increases.

C. When water boils at 100°C and turns into steam, the kinetic energy of the water molecules increases.

D. When water boils at 100°C and turns into steam, the potential energy of the water molecules increases.

79. < HKDSE 2012 Paper IA - 2 >

When a patient's arm is wiped by a piece of cotton soaked with alcohol, the wiped area will feel cool as that patch of alcohol on the skin evaporates. Which statement explains this phenomenon ?

A. The evaporation of alcohol absorbs heat from the patient's arm.

B. The alcohol on the skin releases latent heat to the surrounding air.

C. The motion of all the molecules in the patch of alcohol slows down.

D. Air molecules remove heat from the patch of alcohol by conduction.

80. < HKDSE 2013 Paper IA - 1 >

Which of the following statements about *boiling* and *evaporation* of a liquid is/are correct ?

(1) A liquid absorbs energy when it boils but does not absorb energy when it evaporates.

(2) Boiling occurs at a definite temperature while evaporation takes place above room temperature.

(3) Boiling occurs throughout the liquid while evaporation only takes place at the liquid's surface.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

81. < HKDSE 2013 Paper IA - 2 >

In an experiment to measure the specific latent heat of vaporization of water, a beaker of water is boiled off using an electric heater. Which of the following sources of error would lead to an experimental result smaller than the standard value ?

A. Energy is lost to the surroundings.

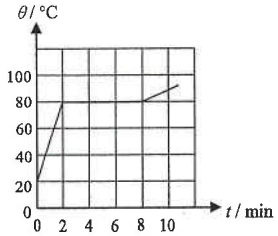
B. Water splashes out of the beaker.

C. Steam condenses on the cooler part of the heater and drops back to the beaker.

D. The heater is not completely immersed in water.

82. < HKDSE 2014 Paper IA - 2 >

An electric heater of constant power is used to heat a solid substance X which is insulated from the surroundings. The variation of its temperature θ with time t is shown. X has a specific heat capacity of 800 J kg^{-1} °C^{-1} in its solid state. What is the specific latent heat of fusion of X?



A. 144 kJ kg^{-1}

B. 192 kJ kg^{-1}

C. 202 kJ kg^{-1}

D. Answer cannot be found as both the mass of X and the power of the heater are not known.

83. < HKDSE 2016 Paper IA - 2 >

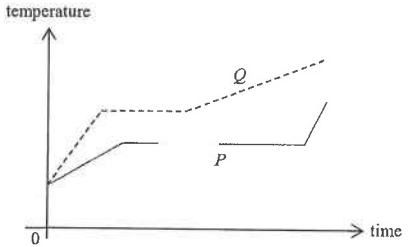
0.3 kg of water at temperature 50°C is mixed with 0.2 kg of ice at temperature 0°C in an insulated container of negligible heat capacity. What is the final temperature of the mixture ?

Given : specific heat capacity of water = 4200 J kg^{-1} °C^{-1}
specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}

A. − 1.8°C
B. 0°C
C. 1.8°C
D. 3.0°C

84. **< HKDSE 2017 Paper IA - 2 >**

Same mass of solids P and Q are heated at the same rate. The temperature-time graphs of the two substances are shown below.



Which of the following comparisons about their melting points and specific latent heats of fusion is correct ?

	higher melting point	larger specific latent heat of fusion
A.	P	P
B.	P	Q
C.	Q	P
D.	Q	Q

85. **< HKDSE 2017 Paper IA - 3 >**

Which of the following statements about the internal energy of a substance are correct ?

(1) When a solid melts, the latent heat of fusion absorbed becomes potential energy of the molecules in the substance.
(2) When a vapour condenses, its internal energy decreases.
(3) When a liquid evaporates, the internal energy of the remaining liquid increases.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

86. **<HKDSE 2020 Paper IA-2>**

HKEAA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.

M.C. Answers

1. D	11. A	21. D	31. B	41. A
2. C	12. A	22. D	32. C	42. C
3. A	13. A	23. B	33. C	43. A
4. D	14. A	24. A	34. C	44. C
5. D	15. A	25. A	35. B	45. D
6. B	16. C	26. A	36. B	46. B
7. A	17. C	27. A	37. A	47. D
8. C	18. A	28. C	38. B	48. B
9. A	19. B	29. B	39. D	49. D
10. D	20. B	30. B	40. D	50. B
51. A	61. A	71. B	81. B	
52. C	62. D	72. B	82. A	
53. A	63. B	73. D	83. B	
54. B	64. D	74. D	84. C	
55. D	65. A	75. A	85. A	
56. C	66. A	76. B	86. B	
57. B	67. D	77. D		
58. A	68. C	78. D		
59. D	69. D	79. A		
60. D	70. C	80. B		

M.C. Solution

1. D

✓ (1) The temperature of the horizontal line is the freezing point, thus, A has a higher freezing point.

✓ (2) A has a greater specific latent heat of fusion because it takes a longer time for the process of freezing.

✓ (3) $E = P\,t = m\,c\,\Delta T$ $\quad \therefore$ slope of graph $= \frac{\Delta T}{t} = \frac{P}{m \cdot c} \propto \frac{1}{c}$

Liquid A has a smaller absolute value of slope, thus A has the greater specific heat capacity.

2. C

$E = m \cdot \ell_v$ $\quad \therefore P = \frac{E}{t} = \frac{m}{t} \cdot \ell_v$

$(42) = (10^{-4})\ \ell_v$ $\quad \therefore \ell_v = 42 \times 10^4\ \text{J kg}^{-1}$

3. A

As specific latent heat of steam is much greater than the specific latent heat of ice,
part of the latent heat of steam can melt the ice and heat it to become 100°C water to give a mixture of water and steam.

4. D

① $P t_1 = m \ell_v$

② $P t_2 = m c \Delta T$

As t_1 and t_2 are both equal to 100

$\therefore m \ell_v = m c \Delta T$

$\therefore \ell_v = c \Delta T$

$\therefore \ell_v = (1000)(70 - 20) = 50\,000\ \text{J kg}^{-1}$

5. D

S absorbs the greatest amount of energy because

① S undergoes the process of fusion and vaporization when temperature increases from 250 K to 400 K

② S has a higher specific latent heat of fusion and vaporization.

6. B

As specific latent heat of steam is much greater than the specific latent heat of ice,
part of latent heat released by steam can melt the ice and heat it to become 100°C water
to give a mixture of water and steam finally.

7. A

✓ (1) Constant temperature is maintained around 70°C at which solidification occurs.

× (2) Upon state change, liquid and solid are both present.

× (3) Energy is lost to the surroundings during the process of solidification.

8. C

$P t_1 = m c \Delta T$ and $P t_2 = m \ell_v$

Combining the two equations :

$\frac{P t_1}{P t_2} = \frac{m c \Delta T}{m \ell_v}$ $\quad \therefore \frac{P(10)}{P t_2} = \frac{m(4.2)(100 - 20)}{m(2268)}$

$\therefore t_2 = 67.5$ minutes

9. A

✓ (1) Supplied energy is used for state change to increase the potential energy of molecules only.

× (2) Since the temperature does not change, the kinetic energy of molecules must be unchanged.

× (3) Since the kinetic energy of molecules is unchanged, the speed must also be unchanged.

10. D

This is a cooling curve of liquid.
Region P : liquid and then start to change into solid
Region Q : liquid and solid exist together
Region R : solidification still carry on and then complete
Region S : solid only

11. A

As $c < \ell_f < \ell_v$ and $c_{copper} < c_{water}$

$\therefore E_2 < E_4 < E_1 < E_3$

12. A

Longest horizontal region corresponds to greatest amount of latent heat of fusion.

13. A

By $\ell_v = \frac{E}{m}$

✓ A. Heat gain causes more ice to melt, thus m is larger and ℓ_v is smaller.

× B. Heat loss means more energy is given out by heater, thus E is larger and ℓ_v is greater.

× C. Water remains in funnel means less water is present in beaker, thus m is smaller and ℓ_v is greater.

× D. Some extra energy is used to heat the ice to the melting point of 0°C, thus E is larger and ℓ_v is greater.

14. A

× A. The water vapour cannot come out from the beaker and thus the experiment does not work.

✓ B. To ensure that no water jumps out from the beaker.

✓ C. To reduce the heat loss to surroundings.

✓ D. Take average of several experimental data can improve the accuracy of the experiment.

15. A

By $E = P t$

$\therefore P = \frac{E}{t} \propto \frac{1}{t}$ (for same solid to be melted)

If P is doubled, then the time taken t would be halved.

16. C

$P t = m \ell_f$

$\therefore (400) \times (500 - 100) = (0.4) \ell_f$

$\therefore \ell_f = 400 \text{ kJ kg}^{-1}$

17. C

$P t_1 = m c \Delta T$ and $P t_2 = m \ell_v$

Combining the two equations :

$\frac{P t_1}{P t_2} = \frac{m c \Delta T}{m \ell_v}$

$\therefore \frac{P(10)}{P t_2} = \frac{m(4200)(100-20)}{m(2.268\times10^6)}$ $\therefore t_2 = 67.5 \text{ min.}$

18. A

✓ A. Crushed ice can increase the contact area of ice with the heater, thus ensure all energy is supplied to ice.

× B. Some extra energy is used to increase the temperature of the ice to reach the melting point of 0°C.

× C. The two funnels should contain the same mass of ice.

× D. Funnel *Y* is already a control to find out the heat gained from the surrounding air, thus there is no need to wrap the insulating material.

19. B

Substance *Q*, at 20°C, is in between its melting point and boiling point, thus it is a liquid at room temperature.

20. B

$E = m \ell_f$

$E = (0.5) \times (2.1 \times 10^5) \text{ J}$

21. D

× (1) Horizontal part of *X* occurs at a lower temperature. $\therefore$ *X* has a lower melting point.

✓ (2) $E = P t = m c \Delta T$

$\therefore$ slope of graph $= \frac{\Delta T}{t} = \frac{P}{m \cdot c} \propto \frac{1}{c}$

$\therefore$ Greater slope means a smaller specific heat capacity, thus *X* has the smaller one.

✓ (3) Shorter horizontal part of *X* means smaller specific latent heat of fusion of *X*.

22. D

$P t = m \ell_v$

$(150)(200) \times (1 - 20\%) = (0.02) \cdot \ell_v$

$\therefore \ell_v = 1.2 \times 10^6 \text{ J kg}^{-1}$

23. B

× (1) The experiment does not work if covered with a lid since steam cannot come out from beaker.

✓ (2) If the heating coil of heater is not immersed completely, some heat is lost to surrounding air.

× (3) All the water in the beaker has the same temperature since the water must be at boiling point, thus no need to stir.

24. A

× A. The control experiment can find out the heat gained from surroundings, thus no need to cover with a lid.

✓ B. Using melting ice to ensure the ice is at 0°C.

✓ C. To ensure no heat lost to the surroundings.

✓ D. The control must have the identical set-up with the experimental apparatus except that the power supply is not connected, Thus the amount of ice used must be the same in two funnels.

25. A

Heat gained by ice = Heat lost by water

$\therefore m_i L + m_i c \Delta T_i = m_w c \Delta T_w$

$\therefore (0.02) L + (0.02)(4200)(14 - 0) = (0.3)(4200)(20 - 14)$

$\therefore 0.3 \times 4200 \times 6 = 0.02L + 0.02 \times 4200 \times 14$

26. A

✓ A. Wrapping the beaker can reduce heat lost to surrounding air, thus improve the accuracy.

× B. If covering the beaker with a lid, the steam cannot escape and thus the experiment does not work.

× C. The boiling water has uniform temperature at boiling point, thus there is no need to stir the water.

× D. Shorter wires would not affect the power given out by heater.

27. A

Heat lost by the juice to change from 70°C to 0°C = Heat absorbed by the ice to melt completely

$m_{juice} c \Delta T = m_{ice} \ell_v$

$(0.2)(4000)(70 - 0) = m_{ice}(3.34 \times 10^5)$

$\therefore m_{ice} = 0.17 \text{ kg}$

28. C

By $\ell_v = \frac{E}{m}$

✓ (1) If energy is lost to surroundings, *E* is greater and thus ℓ_v is larger than the true value.

✓ (2) If some steam condenses back, then mass of water boiled into steam *m* decreases, thus ℓ_v is larger.

× (3) If some water splashes out, then *m* increases and thus ℓ_v should be smaller than the true value.

29. B

$E = m_i \ell_v + m_w c \Delta T$

$\therefore\ (25000) = (0.05)(3.34 \times 10^5) + (0.05 + x)(4200)(4 - 0)$

$\therefore\ x = 0.44$ kg

30. B

× (1) Specific latent heat involves the change of state, without the change of temperature.

× (2) The change of temperature of a substance does not relate to its boiling point.

✓ (3) By $E = m c \Delta T$, if c is lower, ΔT is greater, thus the rise of temperature for P is faster

31. B

× (1) Since the substance is still under cooling, it loses energy to surrounding in period PQ.

× (2) Since the substance is changed from liquid to solid in period PQ, latent heat is released.

✓ (3) When the substance is changed from liquid to solid, its potential energy is decreased.

32. C

For the same kind of solid, the smaller amount of solid will have the same melting point.

The smaller amount of solid will reach the melting point in a shorter time and also melt in a shorter time.

(by $E = m c \Delta T$, for the same temperature rise, $m\downarrow \therefore E\downarrow$, by $E = P t$, $t\downarrow$ for the same heater)

So the new curve will be steeper and become horizontal (during melting) in a shorter time.

33. C

✓ A. At $t = t_1$, the mass of liquid starts to decrease,
thus the liquid starts boiling and changes to vapour and goes away from the beaker

✓ B. Before boiling at t_1, the temperature of the liquid increases as it absorbs heat.

× C. The specific heat capacity of the liquid should be found by

$$c = \frac{E}{m \cdot \Delta T} = \frac{P \cdot t}{m \cdot \Delta T} = \frac{1000\, t_1}{m_2 \cdot \Delta T}$$

✓ D. The specific latent heat of vaporization of the liquid is found by

$$\ell = \frac{E}{m} = \frac{P \cdot t}{m} = \frac{1000\,(t_2 - t_1)}{m_2 - m_1}$$

34. C

Mass of steam vaporized = 1.60 – 1.45 = 0.15 kg

Energy supplied = 0.10 kWh = $0.10 \times 3600\,000$ = 360 000 J

$$\ell_v = \frac{E}{m} = \frac{360000}{0.15} = 2.40 \times 10^6 \text{ J kg}^{-1}$$

35. B

I. If a polystyrene container is used, less heat is lost to the surrounding air.

By $\ell_v = \frac{E}{m}$ $\therefore E\downarrow \Rightarrow \ell_v\downarrow$

II. If the heater is completely immersed, less heat is lost to the surrounding air.

By $\ell_v = \frac{E}{m}$ $\therefore E\downarrow \Rightarrow \ell_v\downarrow$

36. B

× A. At room temperature, both substances are at solid state.
When temperature stops rising, melting point is reached.
As shown by the graph, melting point of P is higher than that of Q.

✓ B. The slope of the graph is inversely proportional to the specific heat capacity.
As slope of P at solid state is smaller, P has a larger specific heat capacity.

× C. As P takes shorter time for fusion to complete, P has a smaller specific latent heat of fusion.

× D. The time taken for P to reach its boiling point is shorter than that of Q.
Thus the energy required is smaller for P since $E = P t$.

37. A

Mist is the condensation of water vapour into liquid on the cold surface.

Evaporation is the vaporization of liquid into vapour at temperature below boiling point to make the glasses become clear.

38. B

Assume no heat lost to surroundings : $m_i \ell_f + m_i c \Delta T_i = m_w c \Delta T_w$

Since m_i and m_w are equal, thus $\ell_f + c \Delta T_i = c \Delta T_w$

$\therefore\ (3.34 \times 10^5) + (4200)(\theta - 0) = (4200)(100 - \theta)$

$\therefore\ \theta = 10.2°C$ (water at a temperature higher than 0°C)

39. D

× (1) It should be a poor conductor of heat so that heat can hardly enter the interior of the space shuttle.

✓ (2) High melting point can prevent the space shuttle from melting.

✓ (3) High specific heat capacity can make the temperature rise be smaller,
so that the shuttle would not be too hot.

40. D

✓ A. 0°C is between the melting point and the boiling point of the substance, thus it should be in liquid state.

✓ B. The upper temperature for state change is the boiling point.

✓ C. Slope is inversely proportional to the specific heat capacity.
Since the slope in solid state is greater, the specific heat capacity is smaller.

× D. The time taken for the solid to change to liquid is shorter than that for the liquid to change to gas,
thus the specific latent heat of fusion should be smaller than the specific latent heat of vaporization.

41. A

Assume no heat loss to surroundings, energy gained by ice = energy lost by juice

$m_i \cdot \ell_f + m_i \cdot c_w \cdot \Delta T_i = m_j \cdot c_j \cdot \Delta T_j$

$m_i (3.34 \times 10^5) + m_i (4200) (20 - 0) = (2) (4700) (80 - 20)$

$\therefore \ m_i = 1.35$ kg

Number of ice cubes $= \dfrac{1.35}{0.15} = 9$

42. C

× (1) It makes use of the large value of specific heat capacity of water.

× (2) It is due to the large value of specific heat capacity of water.

✓ (3) Steam stores large amount of internal energy. It causes more serious injury to skin as it condenses.

43. A

✓ (1) The molecules escape from the surface of the liquid in evaporation, so it occurs at the surface only.

✓ (2) When the temperature is higher, more molecules can have enough energy to escape from the liquid.

× (3) Since the more energetic molecules have escaped,
the average kinetic energy of the remaining liquid molecules should decrease.

44. C

$P t = m c \Delta T + m' \ell_v$

$\therefore \ P (20 \times 60) = (2) (4200) (100 - 20) + (2 - 1.7) (2.26 \times 10^6)$

$\therefore \ P = 1125$ W

45. D

The average speed of the molecules depends on the average kinetic energy, which in turn depends on the temperature.

Steam at 100°C has the highest temperature, thus the molecules have the highest average speed.

46. B

× (1) Since internal energy depends on mass, material, temperature and state,
an object with higher internal energy may have lower temperature,
and energy must transfer from higher temperature to lower temperature.

× (2) An object may absorb energy or release energy when it changes its state.

✓ (3) The only condition for heat or energy to transfer is temperature difference, from high to low.

47. D

(I) If water splashes out, the mass of water escapes from the cup increases,
by $l = E / m$, the increase of m causes the decrease of l.

(II) If water vapour condenses and drips back, the mass of water escapes from the cup decreases,
by $l = E / m$, the decrease of m causes the increase of l.

48. B

Heat gained by ice = Heat lost by soft drink

$m (3.34 \times 10^5) = (0.3) (5300) (20 - 0)$

$\therefore \ m = 0.0952 \approx 0.10$ kg

49. D

By $E = P t = m c \Delta T$, longer time is needed to heat greater mass of the solid from 30°C to 60°C.

When the temperature reaches 60°C which is the melting point of the solid,

the solid is undergoing state change and thus the temperature remains unchanged.

50. B

Heat required by $P = (300) (218 - 20) = 59400$ J

Heat required by $Q = (500) (132 - 20) = 56000$ J

Heat required by $R = (900) (84 - 20) = 57600$ J

As Q requires the smallest amount of heat, the time needed is smallest, thus Q starts to melt first.

51. A

✓ (1) The heat from the flame conducts through the paper to the water quickly,
thus the heat would not make the paper catch fire.

✓ (2) The maximum temperature of water remains at 100°C, and at this temperature,
the paper would not catch fire.

× (3) Heat transfer from high temperature to low temperature,
thus heat transfer from the flame to the paper tray continuously.

52. C

Between $t = 2$ min to $t = 7$ min, there is $(0.5 - 0.45)$ kg of water boils off to become steam.

By $E = P t = m \ell_v$

$\therefore \ P (7 - 2) \times 60 = (0.5 - 0.45) (2.26 \times 10^6)$

$\therefore \ P = 377$ W

53. A

✓ (1) The water on the skin evaporates to give the cooling effect.

× (2) During evaporation, the water should absorb latent heat of vaporization from the skin,
not latent heat of fusion.

× (3) When steam condenses, latent heat of vaporization is released,
but water cannot release latent heat of vaporization.

54. B

From P to Q, the ice melted to water and then its temperature rises to 40°C

while the temperature of the hot water drops from 60°C to 40°C.

Heat gained by the ice = heat lost by the hot water

$m_i l_f + m_i c \Delta T_i = m_w c \Delta T_w$

$(0.15) l_f + (0.15)(4200)(40 - 0) = (1)(4200)(60 - 40)$

$\therefore\ l_f = 392\,000\ \text{J kg}^{-1}$

55. D

× A. Between P and Q, water is losing heat to the ice.

× B. Between P and Q, the ice is melting, and thus the temperature is unchanged during melting.

× C. At Q, the mixture achieves the same temperature of 40°C and starts to lose heat to the surroundings.

✓ D. As the temperature of the water tends to 20°C, the temperature of the surroundings is 20°C.

56. C

$P t = m l_f$

$\therefore\ (500)\, t = (10)(334 \times 1000)$ $\therefore\ t = \dfrac{10 \times 334 \times 1000}{500}$ s

57. B

$P t = m l_f$

$\therefore\ (150)\, t = (0.03) \times (334000)$ $\therefore\ t = 66.8$ s

58. A

✓ (1) Evaporation can occur at any temperature but boiling can only occur at the boiling point.

✓ (2) Evaporation can only occur at the surface of liquid but boiling takes places inside the liquid.

× (3) Both evaporation and boiling involve latent heat of vaporization.

59. D

✓ (1) Evaporation increases as surface area increases.

✓ (2) Evaporation increases as temperature increases.

✓ (3) Evaporation increases in windy environment.

60. D

✓ (1) Ether would evaporate and the blowing air increases its rate of evaporation.

✓ (2) As evaporation carries away heat, ether cools down. Thus mist forms at the outer surface of the beaker.

✓ (3) As evaporation has cooling effect, water cools and freezes.

61. A

Rate of cooling $= \dfrac{0.1 \times 2.26 \times 10^6}{10 \times 60} = 377\ \text{J s}^{-1}$

62. D

✓ (1) Freon absorbs latent heat of vaporization from the food to evaporate.

✓ (2) Freon condenses to release the latent heat of vaporization.

✓ (3) The refrigerator releases heat at the back through the cooling fins.

63. B

Since the water is placed at the room temperature of 25°C, evaporation starts at 25°C.

Boiling can only start at the boiling point of water which is 100°C.

64. D

When evaporation occurs, high energy molecules escape from the surface of the liquid.

After high energy molecules escape, the average K.E. of the remaining molecules decreases, thus temperature decreases.

65. A

To be a liquid, the temperature should be above the melting point and below the boiling point.

At 1000°C : Aluminium is a liquid ; Mercury is a vapour ; Chlorine is a vapour ; Iron is a solid.

66. A

✓ (1) Since his glasses are cold when he goes out, water vapour would condense onto the cold surface.

✓ (2) Warm air can hold more water vapour before saturation occurs.

× (3) Latent heat of vaporization should be released when water vapour condenses to become water.

67. D

As water evaporates, it absorbs latent heat of vaporization from our bodies, thus we would feel cool.

68. C

The water molecules evaporate from the surface of the sea to the sky to form clouds.

69. D

When water boils, the temperature remains at the boiling point of 100°C and does not rise.

70. C

× (1) Close the window reduces the wind blowing over the clothes, thus the clothes would dry less quickly.

✓ (2) Switch on the dehumidifier makes the air dry, thus the clothes would dry more quickly.

✓ (3) Switch on the radiator increases the temperature of the room, thus the clothes would dry more quickly.

71. B

× (1) Both alcohol and water have evaporation on the two hands.

× (2) Both water and alcohol are liquid, their heat conductivity are similar.

✓ (3) Since alcohol has a greater rate of evaporation,
it absorbs latent heat of vaporization from the right hand at a greater rate, thus the right hand feel cooler.

72. B

✓ (1) Boiling requires latent heat of vaporization, thus energy are absorbed by the liquid.

× (2) During boiling, temperature remains unchanged, thus average kinetic energy remains unchanged.

✓ (3) Average potential energy of vapour is greater than that of water, thus it is increased during boiling.

73. D

✓ (1) A gas cannot change state, thus its temperature must increase when it is heated.

✓ (2) As temperature increases, the average kinetic energy of molecules must increase.

✓ (3) As kinetic energy increases, the molecules must move faster.

74. D

× (1) During condensation, the temperature should remain unchanged.

✓ (2) The vapour releases latent heat of vaporization, thus energy is released to the surroundings.

✓ (3) Average potential energy of liquid is less than that of vapour, thus potential energy decreases.

75. A

✓ A. The internal energy must increase as heat is absorbed by the body.

× B. If the body changes state when it is heated, the temperature would remain unchanged.

× C. If the temperature is unchanged, then the average kinetic energy would also be unchanged.

× D. If the body does not change state during heating, then the average potential energy remains unchanged.

76. B

× A. At R.T., both substances are at solid state. When temperature stops rising, melting point is reached.
As shown by the graph, melting point of P is higher than that of Q.

✓ B. The slope of the graph is inversely proportional to the specific heat capacity.
As slope of P at solid state is smaller, P has a larger specific heat capacity.

× C. As P takes shorter time for fusion to complete, P has a smaller specific latent heat of fusion.

× D. The time taken for P to reach its boiling point is shorter than that of Q.
Thus the energy required is smaller for P since $E = P\,t$.

77. D

× (1) Water is not a good conductor, it does not conduct heat quickly.

✓ (2) Water has high specific heat capacity, thus it can absorb much energy when it reaches the rooftop.

✓ (3) Water has high specific latent heat of vaporization,
thus it can absorb much energy from the rooftop when it evaporates at the rooftop.

78. D

When the temperature increases, only kinetic energy of molecules increases.

When the state changes, only potential energy of molecules changes.

When water boils, it changes the state from liquid to vapour, thus the potential energy of water molecules increases.

79. A

Evaporation is the change of liquid state to vapour state, it needs to absorb the latent heat from the skin,
thus the skin feel cool when it loses heat.

80. B

× (1) Both boiling and evaporation absorb energy (latent heat of vaporization).

× (2) Boiling occurs at a definite temperature is correct,
but evaporation takes place at any temperature, not only room temperature.

✓ (3) Boiling occurs throughout the liquid while evaporation occurs at the surface only.

81. B

× A. By $l_v \uparrow = \dfrac{E\uparrow}{m}$, measured energy supplied E is greater, result of l_v is greater.

✓ B. By $l_v \downarrow = \dfrac{E}{m\uparrow}$, mass escaped from the beaker is greater, result of l_v is smaller.

× C. By $l_v \uparrow = \dfrac{E}{m\downarrow}$, mass escaped from the beaker is smaller, result of l_v is greater.

× D. By $l_v \uparrow = \dfrac{E\uparrow}{m}$, more heat is lost to air and thus E is greater, result of l_v is greater.

82. A

Let the power be P and the mass of the substance be m.

The time for the solid to rise from 20°C to 80°C takes 2 minutes. $\therefore\ P \times (2) = m\,(800) \times (80 - 20)$

The time for the solid to melt completely takes 6 minutes. $\therefore\ P \times (6) = m\,l_f$

Combine the two equations :

$$\therefore\ \frac{P\times(2)}{P\times(6)} = \frac{m\,(800)\times(60)}{m\,l_f}$$

$$\therefore\ l_f = 144\,000\ \text{J kg}^{-1} = 144\ \text{kJ kg}^{-1}$$

83. B

Assume all the ice is melted finally.

Heat gained by the ice = heat lost by the hot water

$m_i l_f + m_i c \Delta T_i = m_w c \Delta T_w$

$(0.2)(3.34 \times 10^5) + (0.20)(4200)(\theta - 0) = (0.3)(4200)(50 - \theta)$

$\therefore \theta = -1.8\ °C$

Since the final temperature cannot be lower than 0 °C for a mixture of ice and water,

the ice has not been completely melted.

Thus, the final temperature should be 0 °C.

84. C

The horizontal part represents the change of state from solid to liquid.

As Q is at a higher position, thus the melting point of Q is higher.

By $P t = m l_v$

$\therefore l_v \propto t$ for same m and same P

$\therefore P$ has a larger specific latent heat of fusion as it takes longer time to melt.

85. A

✓ (1) When a solid melts, it absorbs latent heat of fusion.
This energy becomes the potential energy of the molecules.
As the temperature remains unchanged during melting,
the kinetic energy of the molecules remains unchanged.

✓ (2) When a vapour condenses to liquid state, its potential energy decreases, thus internal energy decreases.

× (3) When a liquid evaporates, the temperature of the remaining liquid decreases,
thus the internal energy of the remaining liquid decreases.

The following list of formulae may be found useful :

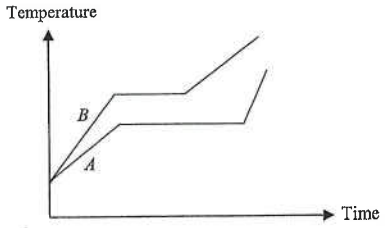
Energy transfer during heating or cooling $E = m c \Delta T$

Energy transfer during change of state $E = l \Delta m$

Part A : HKCE examination questions

1. < HKCE 1979 Paper I - 4 >

(a) Two solids A and B of the same mass are placed in a hot bath and their temperatures are plotted against time as shown in the below figure. Assume that the rates of heat supplied to A and B are the same.



(i) Which of the solids A and B has a higher melting point ? (1 mark)

(ii) Making use of the figure, explain why A should have a higher specific latent heat of fusion than B. (2 marks)

(b) A student carried out an experiment to find the specific latent heat of fusion of ice by the method of mixtures. He placed 0.02 kg of ice at 0°C into a plastic cup (of negligible heat capacity and with good insulation) containing 0.05 kg of water at 20°C. (Specific latent heat of fusion of ice = 336000 J kg^{-1}).

(i) What is the amount of heat required for the ice to change into water at 0°C ? (2 marks)

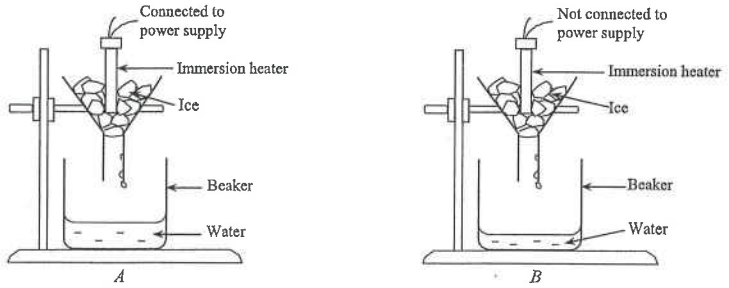
(ii) What is the amount of heat supplied by the water in the cup as it is cooled from 20°C to 0°C ?
(Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$). (2 marks)

(iii) What is the final temperature of the mixture ? (1 mark)

(iv) The student found that he could not obtain a value for the specific latent heat of fusion of ice from the experiment. Why ? Explain briefly. (2 marks)

2. **< HKCE 1985 Paper I - 6 >**

The below figure shows an experimental set-up to determine the specific latent heat of fusion of ice. The ice used is crushed and melting. In the left hand side, *A*, the electrical energy consumed by the heater is measured by a joulemeter. The water from the melted ice was collected in a beaker. In the right hand side, *B*, shows a control experiment of *A* set up without power supply to the heater.



(a) What is the purpose of the control experiment in *B* ? (2 marks)

(b) Why should the ice used in the experiments be (4 marks)

(i) crushed, and

(ii) melting ?

(c) Calculate the specific latent heat of fusion of ice from the following experimental data:

Initial joulemeter reading = 39428 J
Final joulemeter reading = 50328 J
Mass of water collected in *A* = 0.04 kg
Mass of water collected in *B* = 0.01 kg (5 marks)

(d) Would you expect the latent heat of fusion of ice obtained to be higher than, equal to or lower than the result you have been obtained in (c), if the experiment were repeated

(i) neglecting the control experiment ?

(ii) using ice at −5°C ?

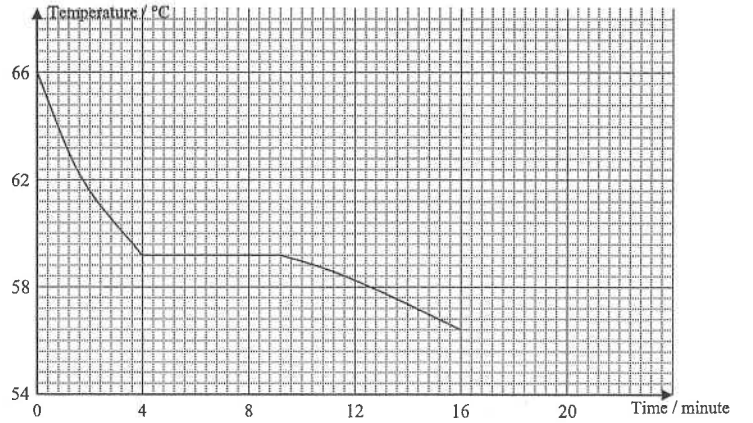
Explain briefly in each case. (4 marks)

(i)

(ii)

3. **< HKCE 1990 Paper I - 4 >**

The below figure shows the cooling curve of a substance changing from liquid to solid state.



(a) **Given a boiling tube half filled with this** substance in its solid state, describe, with the help of a diagram, an experiment to obtain the cooling curve of the substance. (5 marks)

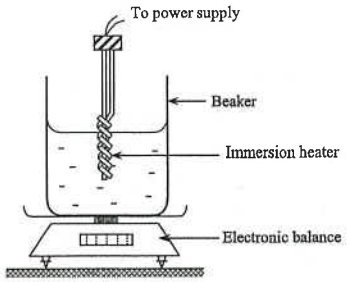
Diagram

(b) Read from the above cooling curve the melting point of the substance. (1 mark)

(c) Explain why the temperature remains constant as the substance solidifies at its melting point, even though heat is lost to the surroundings. (2 marks)

(d) If the mass of substance used is 0.05 kg and the rate of heat loss to the surroundings is 25 W at its melting point, find the specific latent heat of fusion of the substance. (3 marks)

4. **< HKCE 1993 Paper I - 4 >**



A student performs an experiment to find the specific latent heat of vaporization of water. A beaker containing water is placed on an electronic balance. The water is heated by a 100 W immersion heater, which is immersed in the water such that it does not touch the beaker, as shown in the figure above.

(a) It is found that there is a slight decrease in the mass of water in the beaker before the water boils. Explain briefly in terms of molecular motion. (3 marks)

(b) When the water boils, the reading of the balance is taken. After 240 s, the reading of the balance is taken again. The following results are obtained :

Initial reading of the balance = 525.4 g Final reading of the balance = 515.2 g

Calculate (4 marks)

(i) the energy supplied by the heater in 240 s,

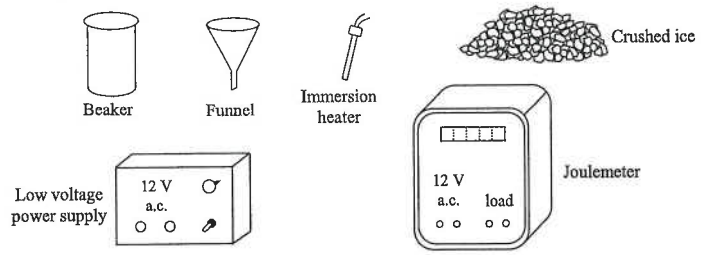
(ii) the specific latent heat of vaporization of water.

(c) The value obtained in (b)(i) is found to be higher than the actual specific latent heat of vaporization of water. Suggest a reason for this and explain briefly. (3 marks)

(d) If the student covers the beaker with a lid, how would the result of the experiment be affected ? Explain briefly. (3 marks)

(e) Suggest TWO improvements on the set-up to increase the accuracy of the experiment. (2 marks)

5. **< HKCE 1997 Paper I - 4 >**



A student uses the apparatus shown in the above figure to perform an experiment to measure the specific latent heat of fusion of ice. He uses a joulemeter to measure the energy required to melt a certain amount of ice.

(a) Draw a diagram to show how the apparatus can be set up for the experiment. (3 marks)

(b) The following data are obtained in the experiment :

Initial joulemeter reading = 28 000 J
Final joulemeter reading = 40 400 J
Mass of water collected in the beaker = 0.045 kg.

Calculate the specific latent heat of fusion of ice. (3 marks)

(c) Why should the ice used in the experiment be crushed ? (2 marks)

(d) A teacher comments that the result of this experiment is not accurate. He points out that a control experiment is required in order to improve the accuracy of the experiment.

(i) Describe how the control experiment can be set up and explain its function. (4 marks)

(ii) After setting up the control experiment, the student repeats the above experiment. Would you expect the specific latent heat of fusion obtained to be higher or lower than that obtained in (b) ? Explain your answer. (2 marks)

6. **< HKCE 1999 Paper I - 2 >**

0.1 kg of melting ice is added to 0.5 kg of water at 30°C in a foam cup. Find the final temperature of the mixture. (Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$, Specific latent heat of fusion of ice = 3.4×10^5 J kg^{-1}.) (4 marks)

7. **< HKCE 2001 Paper I - 6 >**

Explain the following phenomena :

(i) Steam at 100°C causes more severe burns to human skin than boiling water. (2 marks)

(ii) A cup of water gradually loses his weight when it is placed at room temperature. (2 marks)

(iii) We feel cold when we get out of the swimming pool without drying our body. (2 marks)

8. **< HKCE 2002 Paper I - 9 >**

Yunnan Guoqiao-mixian (雲南過橋米線) is a famous Chinese food. In preparing the food, the first step is to cook a pot of chicken soup : A pot of water containing chickens is heated over a high flame until boils. A low flame is then used to keep the soup boiling for 3 hours.

(a) Explain why the temperature of the boiling soup remains unchanged, even though it is being heated. (2 marks)

(b) (i) The power output of the low flame is 300 W. If 70% of the energy supplied is lost to the surroundings, calculate the mass of soup that would be vaporized after being heated for 3 hours. Assume that the specific latent heat of vaporization of the soup is 2.26×10^6 J kg^{-1}. (3 marks)

(ii) Explain why it is undesirable to use a high flame to keep the soup boiling. (1 mark)

8. (c)

Customers ordering the food are served with the following :

a bowl of hot soup with a layer of oil on the surface,
a dish of thin slices of raw meat, and
a bowl of pre-cooked mixian (noodles)

The meat is first put into the soup. Later, the mixian is also added.

(i) Explain why the meat has to be sliced into thin pieces. (1 mark)

(ii) What is the purpose of adding a layer of oil to the bowl ? (2 marks)

(iii) The following data are given :

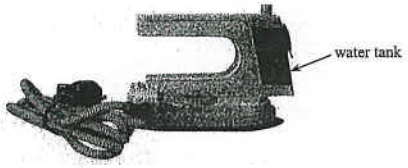
Mass of the soup = 1 kg
Mass of each slice of meat = 0.02 kg
Initial temperature of the soup = 97°C
Initial temperature of the meat = 27°C
Specific heat capacity of the soup = 4200 J kg^{-1} $°C^{-1}$
Specific heat capacity of the meat = 3500 J kg^{-1} $°C^{-1}$

For health reasons, the meat has to be heated to a minimum temperature of 82°C. Estimate the maximum number of slices of meat that can be added to the soup.

State one assumption in your calculation. (4 marks)

(iv) A customer places the mixian into the soup before adding the meat. Explain why this is undesirable. (2 marks)

9. **< HKCE 2003 Paper I - 8 >**



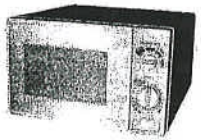
The Figure above shows a travel steam iron with a rated power output of 1100 W. The water tank in the iron is filled with water. When the iron is turned on, water drips continuously from the tank to a hot plate inside the iron, generating steam for ironing clothes. Assume the initial temperature of the water drops is 20°C.

Given : Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$, specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}.

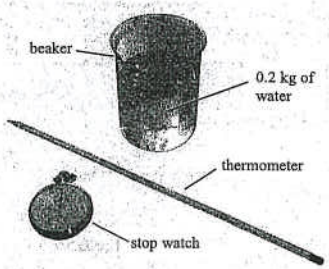
(a) Calculate the energy required to vaporize 1 kg of water at 20°C into steam. (2 marks)

(b) Assume that 80% of the power output of the iron is used to generate steam. Estimate the maximum mass of steam that can be generated by the iron in 1 s. (2 marks)

10. **< HKCE 2004 Paper I - 8 >**



The Figure above shows a microwave oven. Mary wants to conduct an experiment to estimate the useful output power of the oven. She is provided with the apparatus and material shown in the Figure below.



(a) Describe how Mary should conduct the experiment. Specify all measurements that Mary has to take and write down an equation for calculating the useful output power. (4 marks)

10. (b) The value obtained by Mary is found to be smaller than the specified power of the oven. Suggest one possible reason to account for this difference. (1 mark)

(c) Mary suggests that the following measures would improve the accuracy of the experiment :

1. Replacing the beaker with a container with a smaller heat capacity.
2. Increasing the mass of water used in the experiment.

Explain whether each of the above measures would work. (3 marks)

(d) Mary uses the oven to defrost a piece of meat of mass 0.2 kg. The meat is taken from a freezer, the temperature of which is maintained at – 20°C. Assume that 70% of the mass of the meat is made up of water.

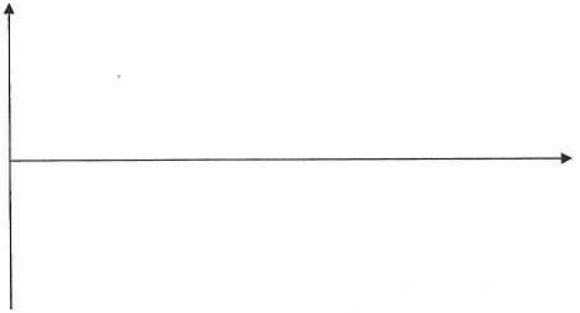
Given : specific heat capacity of the frozen meat = 1700 J kg^{-1} $°C^{-1}$,
specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}.

(i) Find

(1) the energy required to raise the temperature of the meat from –20 °C to 0 °C, and

(2) the energy required to change the ice in the meat at 0 °C to water. (4 marks)

(ii) Sketch a graph to show the variation of the temperature of the meat with time during the defrosting process. (2 marks)



11. **< HKCE 2005 Paper I - 3 >**

William makes a glass of hot tea (as shown in Figure 1). After a while, he adds some ice cubes into the tea. William uses a temperature sensor to measure the temperature of the tea. Figure 2 shows the temperature-time graph obtained.

Figure 1

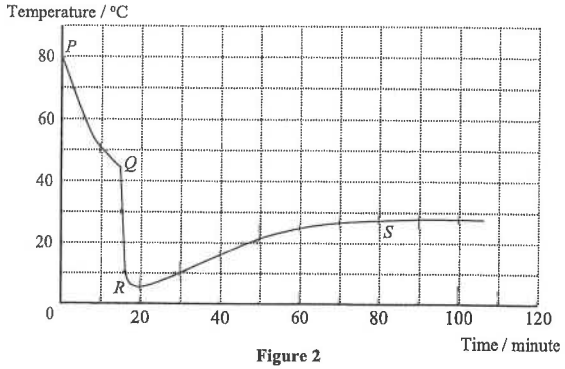


Figure 2

(a) William stirs the tea throughout the experiment. Why does he need to do this ? (1 mark)

(b) *P*, *Q*, *R* and *S* are four points on the graph. State the point which corresponds to each of the following :

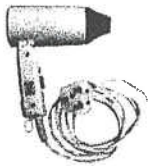
(i) The instant at which the ice cubes are added. (1 mark)

(ii) The instant at which all the ice cubes melt. (1 mark)

(c) Explain why the temperature of the tea increases from *R* to *S*. (2 marks)

(d) Estimate the temperature of the surroundings. (1 mark)

12. **< HKCE 2005 Paper I - 11 >**



The above hairdryer can generate warm air. Carmen uses the above dryer to dry her wet hair. Explain, in terms of molecular motion, how the dryer can speed up the rate of evaporation of water from wet hair. (2 marks)

13. **< HKCE 2006 Paper I - 10 >**

Dehumidifiers (see Figure 1) are used to lower the humidity of air. Wet air flows into Part *A* of the dehumidifier and dry air flows out from Part *B* of the dehumidifier as shown in Figure 2. A liquid called the refrigerant circulates through the coiled tube. The refrigerant absorbs heat from the wet air and evaporates inside the coiled tube in Part *A*. The vapour of the refrigerant is then pumped to the coiled tube in Part *B* where it is compressed and condenses into a liquid. The liquid refrigerant then passes back to the coiled tube in Part *A* and the process is repeated.

Dehumidifier

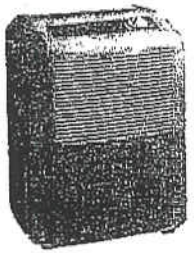


Figure 1

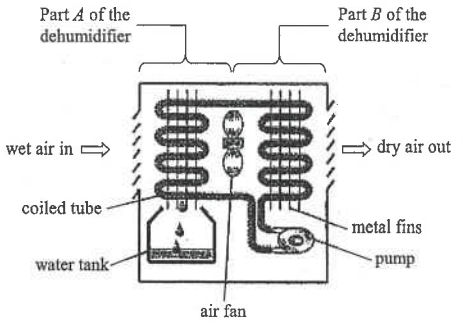


Figure 2

(a) In terms of molecular motion, explain why the temperature of the refrigerant drops when it evaporates inside the coiled tube in Part *A*. (2 marks)

(b) Explain why the coiled tube in Part *A* is designed in a coiled shape. (2 marks)

(c) In the coiled tube in Part *B*, the vapour of the refrigerant is compressed and condenses into liquid. State the change of the average potential energy of the refrigerant molecules during this process of changing state. (1 mark)

(d) When the dehumidifier is in operation, the coiled tube in Part *B* gives out heat. State and explain two designs that could prevent the dehumidifier from overheating. (2 marks)

13. (e) The dehumidifier is turned on for a few hours in a closed room. Water vapour in the incoming wet air condenses and 1.5 kg of water is collected in the water tank (see Figure 2).

(i) Estimate the total energy released by the water vapour. Given that the specific latent heat of vaporization of water is 2.26×10^6 J kg^{-1}. (2 marks)

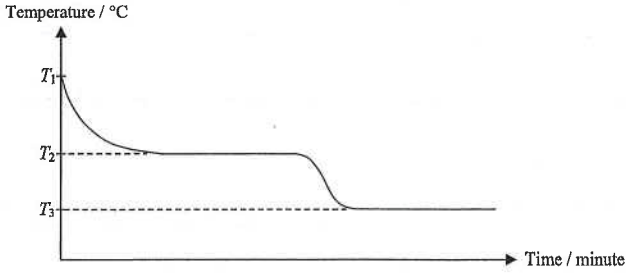
(ii) Using the data and the formula in the below Table, estimate the increase in temperature of the air in the room, assuming that all the energy released in Part *B* is used to raise the temperature of the air inside the room. (3 marks)

Volume of the air in the room = 400 m^3
Density of the air = 1.3 kg m^{-3}
Specific heat capacity of the air = 1030 J kg^{-1} °C^{-1}
Mass = density × volume

14. **< HKCE 2007 Paper I - 4 >**

Karen puts 0.12 kg of water at room temperature T_1 into the freezer of a refrigerator to make ice cubes. The cooling curve of the water is shown in the Figure below.

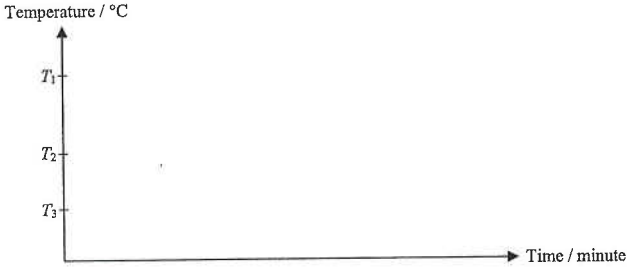
Given : specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}



(a) State the physical meaning of temperature T_2. (1 mark)

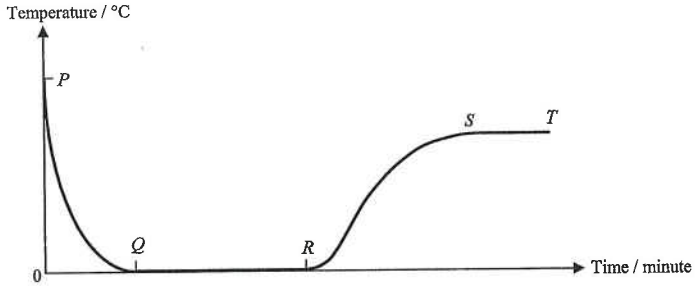
(b) Find the latent heat released in the above process. (2 marks)

14. (c) If an ice cube from the freezer is placed at room temperature T_1, sketch a graph in the figure below to show the expected change in temperature of the ice cube. (3 marks)



15. **< HKCE 2009 Paper I - 3 >**

At time $t = 0$, Mary adds several ice cubes at 0°C into a glass of warm water. The temperature-time graph of the water is shown in the Figure below.



(a) State the instant at which all ice cubes melt. (1 mark)

(b) Explain why there is no change in temperature

(i) from *Q* to *R*, (2 marks)

(ii) from *S* to *T*. (1 mark)

16. **< HKCE 2009 Paper I - 4 >**

The figures below show an electric steam iron. The iron is automatically switched off when the ironing plate is heated to 200°C. When the 'jet steam' button is pressed once, 20 g of water at 28°C will be pumped onto the heated plate at 200°C and the water is converted into steam at 100°C instantly.

Given : specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$
specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}

(a) (i) Estimate the energy required to produce 20 g of steam from water at 28°C. (3 marks)

(ii) Given that the heat capacity of the ironing plate is 637 J $°C^{-1}$. Estimate the temperature of the plate after producing 20 g of steam. (2 marks)

(b) The iron cannot convert 40 g of water at 28°C to steam when the button has been pressed twice quickly. Explain why. (2 marks)

17. **< HKCE 2010 Paper I - 4 >**

The Figure shows an electric kettle connected to the mains supply.

Power of the kettle = 1500 W
Mass of water in the kettle = 1.3 kg
Initial temperature of water in the kettle = 25°C
Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$
Specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}

The kettle is switched on and it takes 5 minutes for the water to start boiling. Assume all electrical energy supplied is transferred to the kettle and water inside, and their temperatures are the same.

(a) Estimate the heat capacity of the kettle. (4 marks)

(b) The kettle is kept switched on for 10 more minutes after boiling. Estimate the mass of water remaining in the kettle. Assume all the steam produced escapes from the kettle. (2 marks)

18. **< HKCE 2011 Paper I - 4 >**

Figure (a) shows a fish tank heater that is used to regulate the temperature of water in the fish tank. It is fully immersed in the water as shown in Figure (b)

Figure (a)

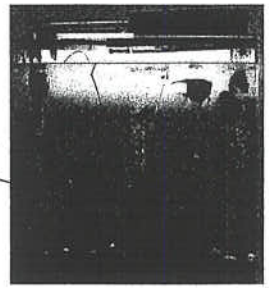


Figure (b)

Given : specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$
specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}

(a) Explain why the heater should be placed near the bottom of the tank. (2 marks)

(b) The mass and initial temperature of water inside the tank are 90 kg and 25°C respectively. The heater is switched on to heat the water.

(i) The power of the heater is 100 W. Estimate the time required for the heater to heat the water to 27°C. (3 marks)

(ii) In practice, there is heat loss to the surroundings during heating. Explain how this would affect the time calculated in (b) (i). (2 marks)

(c) After a few days, it is found that the amount of water inside the tank decreases due to evaporation.

(i) Suggest a method to reduce the rate of evaporation of the water inside the tank. (1 mark)

(ii) On average, the mass of water inside the tank decreases by 0.2 kg in one day. Estimate the energy carried away by evaporation in one day. (2 marks)

Part B : HKDSE examination questions

19. < HKDSE 2012 Paper IB - 1 >

Figure 1

Cappuccino is an Italian style coffee topped with a layer of frothy milk (Figure 1).

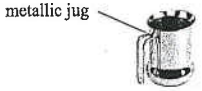


Figure 2

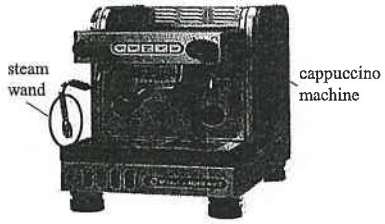


Figure 3

Frothy milk is made by bubbling steam through milk, which is held in a metallic jug (Figure 2). Steam is ejected from the steam wand of a cappuccino machine (Figure 3).

Given : specific latent heat of vaporization of water = 2.26×10^6 J kg^{-1}
specific heat capacity of water = 4200 J kg^{-1} °C^{-1}
specific heat capacity of steam = 2000 J kg^{-1} °C^{-1}
specific heat capacity of milk = 3900 J kg^{-1} °C^{-1}

(a) Calculate the total amount of heat released when 20 g of steam at 110°C cools to 100°C and condenses to water at 100°C. (3 marks)

(b) 20 g of steam at 110°C is bubbled through 200 g of milk at 15°C to make frothy milk. Using the result in (a), calculate the temperature of the frothy milk. (2 marks)

(c) Would the actual temperature of frothy milk be higher than, equal to or lower than the value found in (b) ? Explain. (2 marks)

HKEAA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.

Question Solution

1. (a) (i) *B* has a higher melting point. [1]

(ii) The time taken by *A* to melt is longer than that of *B*. [1]

Therefore, *A* requires larger heat (**OR** greater energy) for melting. [1]

(b) (i) $E = m\ell$

$= (0.02) \times (336000)$ [1]

$= 6720$ J [1]

(ii) $E = mc\Delta T$

$= (0.05) \times (4200) \times (20 - 0)$ [1]

$= 4200$ J [1]

(iii) The final temperature of the mixture is 0°C. [1]

(iv) The student has used too much ice. (**OR** The student has used too little water.) [1]

Therefore, the ice would not melt completely after the experiment. [1]

2. (a) ANY **ONE** of the followings : [2]

* To find out the mass of ice melted due to the heat gained from the surroundings
* To find out the mass of ice actually melted by the heater.

(b) (i) The ice should be crushed to increase the surface area of the ice and [1]

ensure good contact of the ice with the heater. [1]

(ii) To ensure the temperature of the ice is at 0°C. [2]

(c) Energy transfer = (50328 – 39428) = 10900 J [1]

Mass of ice actually melted by heater = 0.04 – 0.01 = 0.03 kg [1]

By $E = ml$ [1]

$\therefore (10900) = (0.03)\, l$ [1]

$\therefore l = 3.63 \times 10^5$ J kg^{-1} [1]

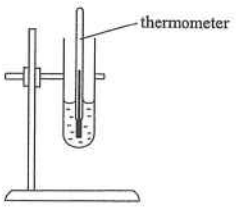
(d) (i) Lower [1]

Since mass of ice melted is larger than the actual value. [1]

(ii) Higher [1]

Since extra amount of energy is used to raise the ice from –5°C to 0°C [1]

3. (a)



[1]

Heat the substance until all changes into liquid and is about 10°C above the melting point. [1]
Allow the tube to cool in air. [1]
Record the temperature at 1 minute interval [1]
until a few degrees below the melting point. [1]

(b) 59.2°C [1]

(c) The substance is losing latent heat of fusion in changing from liquid to solid state. [2]

OR

Potential energy is lost when molecules come close together to form the solid state. [2]

(d) Time = 9.2 – 4 = 5.2 min < 5.2 to 5.6 is acceptable > [1]

$P\,t = m\,\ell$ [1]

$\therefore \quad (25) \times (5.2 \times 60) = (0.05)\,\ell$

$\therefore \quad \ell = 1.56 \times 10^5 \text{ J kg}^{-1}$ < 1.56 to 1.68 is acceptable > [1]

4. (a) Kinetic energy (**OR** speed) of the water molecules increases with temperature. [1]
Some fast moving molecules [1]
then escape from the water, so the mass of water decreases. [1]

(b) (i) $E = P\,t = (100) \times (240)$ [1]
$= 2.4 \times 10^4 \text{ J}$ [1]

(ii) $\ell = \dfrac{E}{m} = \dfrac{(2.4 \times 10^4)}{(525.4 - 515.2) \times 10^{-3}}$ [1]

$= 2.36 \times 10^6 \text{ J kg}^{-1}$ [1]

(c) There is heat loss to the surrounding from the beaker [1]
so energy supplied by the heater is greater than the energy absorbed by the water. [2]

OR

Some water vapour condenses on the beaker, [1]
so the change in mass measured is smaller than the actual mass of water vaporized. [2]

4. (d) The experiment does not work. [1]
As the water vapour cannot escape freely, [1]
so the actual mass of water vaporized cannot be measured. [1]

OR

The value obtained is higher. [1]
As some vapour will condense on the beaker and the lid [1]
so that the change in mass is smaller. [1]

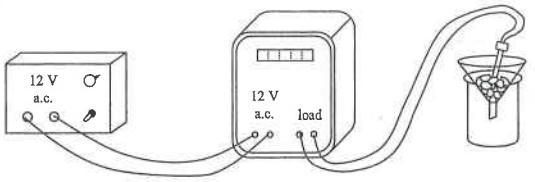
(e) ① Completely immerse the heating coil into the water. [1]

② Either **ONE** of the following : [1]

* Wrap the beaker with insulating material.
* Use a plastic beaker.
* Replace the beaker by a polystyrene cup

< Note that well stir the water **OR** cover the beaker with a lid **are not acceptable** >

5. (a)



< heater and ice in the funnel > [1]
< beaker under the funnel > [1]
< connection of joulemeter > [1]

(b) Energy supplied = 40400 – 28000 = 12400 J [1]

Specific latent heat of fusion :

$\ell = \dfrac{E}{m} = \dfrac{12400}{0.045}$ [1]

$= 2.76 \times 10^5 \text{ J kg}^{-1}$ [1]

(c) Any **ONE** of the following : [2]

* To ensure a good contact between the ice and the heater.
* To increase the surface area of contact between the ice and the heater.
* To enable the temperature of ice to be more close to 0°C

(d) (i) The set-up for the control experiment is identical to the original set-up [1]
except that the heater is not connected to the power supply. [1]
The control experiment can measure the amount of ice melted [1]
due to energy gained from the surrounding air. [1]

5. (d) (ii) The value obtained is higher than that in (b) as some ice melts due to heat gained from surrounding air, [1]
so the true amount of ice melted by the heater is smaller than that collected in the beaker. [1]

6. Energy gained by the ice = Energy lost by the water [1]
$\therefore\ m_i \ell + m_i c \Delta T_i = m_w c \Delta T_w$
$\therefore\ 0.1 \times 3.4 \times 10^5 + 0.1 \times 4200 \times \theta = 0.5 \times 4200 \times (30 - \theta)$ [2]
$\therefore\ \theta = 11.5°C$ [1]

7. (i) Steam will give out a large amount of latent heat of vaporization [1]
when it condenses. [1]

(ii) Evaporation occurs [1]
since high energy water molecules escape from the surface of water. [1]

(iii) Evaporation occurs [1]
and latent heat of vaporization is absorbed from the body. [1]

8. (a) The soup is absorbing latent heat of vaporization in changing its state. [2]

(b) (i) Energy given out by the flame $= P t = 300 \times 3 \times 3600 = 3\,240\,000$ J [1]
By $E = m l_v$ [1]
$\therefore\ (3240\,000 \times 30\%) = m (2.26 \times 10^6)$
$\therefore\ m = 0.430$ kg [1]

(ii) If a high flame is used, a large amount of soup will be vaporized in 3 hours. [1]

(c) (i) To increase the contact area between the meat and the soup. [1]

(ii) The layer of oil reduces the heat lost to the surrounding air [1]
due to evaporation. [1]

(iii) Energy lost by the soup = Energy gained by the meat
$(1)(4200)(97 - 82) = (0.02\ n)(3500)(82 - 27)$ [2]
$\therefore\ n = 16.4$
The maximum number of slices of meat that can be added is 16. [1]
Assumption : There is no heat lost to the surroundings. [1]

(iv) If the mixian is placed into the soup first, the temperature of the soup would largely drop, [1]
thus the soup may not have sufficient energy to cook the meat. [1]

9. (a) $E = m c \Delta T + m l_v$
$= (1)(4200)(100 - 20) + (1)(2.26 \times 10^6)$ [1]
$= 2\,596\,000$ J [1]

(b) Useful energy output in 1 s $= (1100)(1) \times 80\% = 880$ J [1]
Maximum mass of steam generated in 1 s $= \dfrac{880}{2596000} = 3.39 \times 10^{-4}$ kg [1]

10. (a) Put the thermometer into the water to measure its initial temperature T_1. [1]
Put the beaker of water into the oven and turn on the oven. [1]
Record the time of heating t by using the stop watch. [1]
Take out the beaker of water from the oven and measure its final temperature T_2.
Output power is found by : $P = \dfrac{0.2 \times c \times (T_2 - T_1)}{t}$ [1]

(b) Any **ONE** of the following : [1]
* Some energy is absorbed by the beaker.
* Some energy is lost to the surrounding air.
* Some energy is lost to evaporate (OR vaporize) the water.

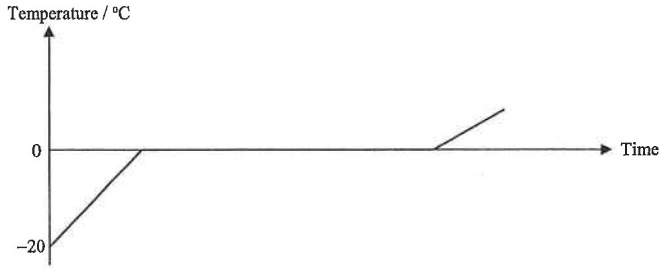
(c) 1. Energy absorbed by the container would become smaller, [1]
thus it can improve the accuracy.

2. The percentage of energy lost would become smaller, [1]
thus it can improve the accuracy. [1]

(d) (i) (1) $E = m c \Delta T = (0.2) \times (1700) \times (20)$ [1]
$= 6800$ J [1]

(2) $E = m \ell = (0.2 \times 70\%) \times (3.34 \times 10^5)$ [1]
$= 46\,760$ J < accept 46 800 J OR 46.8 kJ > [1]

(ii)



< Temperature rises from –20°C to 0°C > [1]
< Temperature remains at 0°C for a period of time > [1]

11. (a) To ensure uniform temperature of the tea. [1]

(b) (i) point Q [1]

(ii) point R [1]

(c) Since the temperature of the tea is lower than the surroundings, [1]
heat flows from the surroundings to the tea. [1]

(d) 28°C <26°C to 29°C acceptable> [1]

12. The average kinetic energy of the water molecules in the hair will increase,
thus more water molecules at the water surface gain enough energy to escape from the water. [1]

Moreover, the water molecules escaped from the water surface will be blown away by the wind from the dryer. [1]

13. (a) When the fast moving molecules escape from the liquid, [1]
the average kinetic energy of the molecules in the liquid decreases, thus temperature drops. [1]

(b) It can increase the area of contact with air [1]
and thus help to condense the water vapour in the air. [1]

(c) Average potential energy is decreased. [1]

(d) Any **TWO** of the followings : [2]

- ✱ The tube is in dark colour to increase the radiation of heat.
- ✱ The air fan increase the flow of air.
- ✱ The metal fins carry away heat by conduction.
- ✱ The vent hole in part B increase the flow of air.

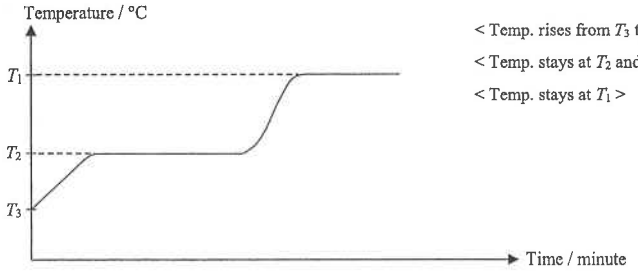
(e) (i) $E = m\ell$ [1]
$= (1.5) \times (2.26 \times 10^6)$
$= 3390\ 000$ J [1]

(ii) Mass of air $= 400 \times 1.3 = 520$ kg [1]
By $E = mc\Delta T$ [1]
$\therefore\ (3390\ 000) = (520) \times (1030) \times \Delta T$
$\therefore\ \Delta T = 6.33$°C [1]

14. (a) T_2 is the melting point of ice. **OR** T_2 is the freezing point of water. [1]

(b) $E = m\ell$ [1]
$= (0.12)(3.34 \times 10^5) = 40100$ J [1]

14. (c)



<Temp. rises from T_3 to T_2 and stays at T_2> [1]
<Temp. stays at T_2 and then rises to T_1> [1]
<Temp. stays at T_1> [1]

15. (a) R [1]

(b) (i) Water temperature decreases to the melting point of 0°C. [1]
Ice at 0°C is still melting. [1]

(ii) Water reaches the room temperature. [1]

16. (a) (i) $E = mc\Delta T + ml$ [2]
$= (0.02)(4200)(100 - 28) + (0.02)(2.26 \times 10^6)$
$= 51248$ J <accept 51200 J> [1]

(ii) $(51248) = (637)(200 - T)$ [1]
$T = 120$°C [1]

(b) To produce 40 g of steam, the temperature of the plate will be decreased by 160°C. [1]
It will then be lower than the boiling point of water. [1]

17. (a) Energy supplied by the kettle
$= Pt$ [1]
$= (1500) \times (5 \times 60) = 450000$ J

Energy gained by water
$= mc\Delta T = (1.3)(4200)(100 - 25) = 409500$ J

$\therefore\ 450000 = 409500 + C(100 - 25)$ [2]
$\therefore\ C = 540$ J °C^{-1} [1]

<OR>

$Pt = mc\Delta T + C\Delta T$ [3]
$(1500)(5 \times 60) = (1.3)(4200)(100 - 25) + C(100 - 25)$
$C = 540$ J °C^{-1} [1]

17. (b) $P\,t = m\,l$ [1]

$(1500)\,(10 \times 60) = m\,(2.26 \times 10^6)$

$m = 0.398$ kg

mass of water remaining in the kettle $= 1.3 - 0.398 = 0.902$ kg [1]

18. (a) By convection, [1]

the temperature of water in the tank will become uniform faster. [1]

(b) (i) $P\,t = m\,c\,\Delta T$ [1]

$(100)\,t = (90)\,(4200)\,(27 - 25)$ [1]

$\therefore\ t = 7560$ s [1]

(ii) More energy need to be supplied to compensate the heat lost. [1]

So it takes a longer time to heat up the water. [1]

(c) (i) Evaporation can be reduced by covering the top of the tank. [1]

(ii) $E = m\,l_v$ [1]

$= (0.2)\,(2.26 \times 10^6)$

$= 452000$ J [1]

19. (a) $E = m\,c\,\Delta T + m\,l_v$ [1]

$= 0.020 \times 2000 \times (110 - 100) + 0.020 \times 2.26 \times 10^6$ [1]

$= 45600$ J [1]

(b) $E + m_s\,c_w\,\Delta T_w = m_m\,c_m\,\Delta T_m$

$(45600) + (0.02)\,(4200)\,(100 - \theta) = (0.200)\,(3900)\,(\theta - 15)$ [1]

$\therefore\ \theta = 76.0$ °C [1]

(c) The actual temperature of the frothy milk is lower. [1]

Some heat is lost to the surrounding air. (**OR** to the metallic jug) [1]

Hong Kong Diploma of Secondary Education Examination

Physics – Compulsory part (必修部分)

Section A – Heat and Gases (熱和氣體)
1. Temperature, Heat and Internal energy (溫度、熱和內能)
2. Transfer Processes (熱轉移過程)
3. Change of State (形態的改變)
4. General Gas Law (普適氣體定律)
5. Kinetic Theory (分子運動論)

Section B – Force and Motion (力和運動)
1. Position and Movement (位置和移動)
2. Newton's Laws (牛頓定律)
3. Moment of Force (力矩)
4. Work, Energy and Power (作功、能量和功率)
5. Momentum (動量)
6. Projectile Motion (拋體運動)
7. Circular Motion (圓周運動)
8. Gravitation (引力)

Section C – Wave Motion (波動)
1. Wave Propagation (波的推進)
2. Wave Phenomena (波動現象)
3. Reflection and Refraction of Light (光的反射及折射)
4. Lenses (透鏡)
5. Wave Nature of Light (光的波動特性)
6. Sound (聲音)

Section D – Electricity and Magnetism (電和磁)
1. Electrostatics (靜電學)
2. Electric Circuits (電路)
3. Domestic Electricity (家居用電)
4. Magnetic Field (磁場)
5. Electromagnetic Induction (電磁感應)
6. Alternating Current (交流電)

Section E – Radioactivity and Nuclear Energy (放射現象和核能)
1. Radiation and Radioactivity (輻射和放射現象)
2. Atomic Model (原子模型)
3. Nuclear Energy (核能)

Physics – Elective part (選修部分)

Elective 1 – Astronomy and Space Science (天文學和航天科學)
1. The universe seen in different scales (不同空間標度下的宇宙面貌)
2. Astronomy through history (天文學的發展史)
3. Orbital motions under gravity (重力下的軌道運動)
4. Stars and the universe (恆星和宇宙)

Elective 2 – Atomic World (原子世界)
1. Rutherford's atomic model (盧瑟福原子模型)
2. Photoelectric effect (光電效應)
3. Bohr's atomic model of hydrogen (玻爾的氫原子模型)
4. Particles or waves (粒子或波)
5. Probing into nano scale (窺探納米世界)

Elective 3 – Energy and Use of Energy (能量和能源的使用)
1. Electricity at home (家居用電)
2. Energy efficiency in building (建築的能源效率)
3. Energy efficiency in transportation (運輸業的能源效率)
4. Non-renewable energy sources (不可再生能源)
5. Renewable energy sources (可再生能源)

Elective 4 – Medical Physics (醫學物理學)
1. Making sense of the eye (眼的感官)
2. Making sense of the ear (耳的感官)
3. Medical imaging using non-ionizing radiation (非電離輻射醫學影像學)
4. Medical imaging using ionizing radiation (電離輻射醫學影像學)