

Name of the Student: _____

Max. Marks : 17 Marks

Time : 17 Minutes

Mark Schemes

Q1.

- (a) total kinetic energy of the particles ✓

Condone "molecules" or "atoms" for "particles"

Kinetic energy will be taken to mean total kinetic energy but do not accept use of mean kinetic energy or reference to kinetic energy of a single particle.

Do not allow any reference that implies there is potential energy or any other energy added to the kinetic energy.

1

- (b) (the speed before and after a collision is the same in the elastic collision)

$$\Delta p (= p_f - p_i) = -mc - mc = -2mc \quad \checkmark$$

Use of subscripts i and f or before and after do not need explanation.

Δ will be assumed to mean (final - initial).

Either the initial momentum or the final momentum must be described clearly enough to justify the negative final answer

1

- (c) Time between colliding with **W** $(= \frac{s}{c}) = \frac{2l}{c}$

$$f = \frac{1}{T} \left(= \frac{c}{2l} \right) \quad \checkmark$$

Must show evidence of a time calculation using distance and speed

Do not allow any attempted use of $v = f\lambda$

1

- (d) Reference to a Newton law **AND** $P = \frac{F}{A}$ ✓₁

$$P \left(= \frac{F}{A} = \frac{mc^2}{l} \times \frac{1}{l^2} \right) = \frac{mc^2}{V} \quad \checkmark_2$$

The reference to Newton law could be a simple link between Newton's name and an equation.

2

[5]

Q2.

(a) Attempt to calculate either volume using correct equation ✓₁

Subtracts their two volumes ✓₂

$n = 3.09$ OR 6.46 OR attempt to find one n using $\frac{pV}{RT}$

with correct temperature ✓₃

Calculates $\Delta n = 3.37$ (mol)

OR

Determines both values of n with correct T and p

AND calculates their Δn ✓₄

Molar mass = 0.028 (kg mol^{-1}) ✓₅

✓₁

Condone POT.

$$\frac{\pi h d^2}{4} = \frac{\pi \times 370 \times 10^{-3} \times (660 \times 10^{-3})^2}{4}$$

$$0.1265 \text{ m}^3$$

OR

$$\frac{\pi h d^2}{4} = \frac{\pi \times 370 \times 10^{-3} \times (330 \times 10^{-3})^2}{4}$$

$$0.0316 \text{ m}^3$$

$$\checkmark_2 V = 0.1265 - 0.0316 = 0.0949 \text{ (m}^3\text{)}$$

Correct answer will be given ✓₁ ✓₂

✓₃ Correct answer will be given ✓₁ ✓₂

$$\frac{pV}{RT} = \frac{1.01 \times 10^5 \times 0.0949}{8.31 \times (100 + 273)}$$

$$= (3.09) \text{ or}$$

$$\frac{pV}{RT} = \frac{2.11 \times 10^5 \times 0.0949}{8.31 \times (100 + 273)}$$

$$= (6.46)$$

$$\checkmark_4 \Delta n = 6.46 - 3.09 = 3.37 \text{ (mol)}$$

Correct answer will be given ✓₃ ✓₄

$$\checkmark_5 \text{ molar mass} = \frac{14.991 - 14.897}{3.37} = \frac{0.094}{3.37}$$

$$= 0.028 \text{ (kg mol)}$$

5

(b) (Carrying out the check) at a higher temperature increases the pressure in the tyre. ✓₁

(Thus) the tyre could pass the check with a smaller amount of gas in the tyre.

OR

(When the tyre is hot) you can achieve the same pressure but with less gas. ✓₂

✓₁ For linking pressure to temperature.

Condone comments suggesting $p \propto T$

✓₂ For linking less gas/smaller n to a passing check. **OR** For a

Q3.

- (a) Combining and making use of $Q = Pt$ and $Q = mc\Delta\theta$ equations without the need to make t the subject. ✓₁
 $t = 27$ (s) ✓₂

✓₁ numerical errors are ignored for this mark.

Provided the temperature difference is correct then subsequent changes that involve 273 °C can be ignored.

$$\checkmark_2 \quad t = (1.2 \times 450) \frac{(125-20)}{2100}$$

No ecf for the second mark but correct answer gains both marks

Condone use of c_{water} for c_{metal}

2

- (b) (The power supplied in time t raises the temperature of m kg of water and converts it to steam)

Use of appropriate equation. ✓₁

The award of MP3 is dependent on the award of MP1 OR MP2.

Evidence for MP1 can be seen in MP2 via the correct answers in the exemplars below.

Correct evaluation of Δm or P . No ecf. ✓₂

Condone error in time / temperature change / POT for MP1.

Use of m from the metal is not condoned

$$\checkmark_1 \quad Pt = mc_w \Delta\theta + ml \quad \text{OR} \quad P = \frac{mc_w \Delta\theta + ml}{t}$$

✓₂ Several methods can be followed including in 1 minute
 2100×60

$$= \Delta m \times 4200 \times (100 - 20) + \Delta m \times 2.3 \times 10^6$$

$$\Delta m = 0.048 \text{ kg min}^{-1}$$

OR

in one second 2100

$$= \Delta m \times 4200 \times (100 - 20) + \Delta m \times 2.3 \times 10^6$$

Deduction that claim is false (consistent with their value) supported by their calculated quantity
OR

Deduction that their calculated quantity is greater / smaller than required ✓₃

$$\Delta m = 0.00080 \text{ kg s}^{-1}$$

OR

$$P =$$

$$= \frac{0.060 \times 4200 \times (100 - 20) + 0.060 \times 2.3 \times 10^6}{60}$$

$$P = 2.6(4) \times 10^3 \text{ W}$$

OR

Comparing the energy supplied in time eg in a minute (126000 J) with energy needed (138000 + 20160 = 158000 J)

OR

Calculation of time taken to obtain 60 g of steam = 75.3 s.

✓₃ So claim is not true.

0.048 kg min⁻¹ is smaller than 60 g min⁻¹

OR

0.00080 kg s⁻¹ = 48 g min⁻¹ is smaller than 60 g min⁻¹

OR

2.6 × 10³ W is greater (than 2.1 kW / power available)

OR

time to generate 60 g of steam is too long.

(The most common ecf will be to leave out the raising of the water temperature before changing the water to steam giving calculated values of $\Delta m = 0.055 \text{ kg min}^{-1}$, or

$\Delta m = 0.00091 \text{ kg s}^{-1}$ or $P = 2.3 \times 10^3 \text{ W}$)

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[5]