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Inland Transport Committee

Working Party on the Transport of Dangerous Goods

Joint Meeting of Experts on the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) (ADN Safety Committee)

Fifteenth session
Geneva, 24–28 August 2009
Item 5 of the provisional agenda
Catalogue of questions

Gases – knowledge of physics and chemistry, objectives 2.1, 2.2, 3.1, 3.2

Transmitted by the Central Commission for the Navigation of the Rhine (CCNR)[1]

1. At its fourteenth session, the ADN Safety Committee, recalling that, under 8.2.2.7.2.3 of the Regulations annexed to ADN, the ADN Administrative Committee was required to prepare a catalogue of questions for the ADN examinations, decided that the item should be put on the agenda for future sessions, in order to enable lists of questions to be translated and adopted progressively (ECE/TRANS/WP.15/AC.2/30, paras. 38 and 40).

2. This document contains the lists of questions proposed by CCNR in respect of knowledge of physics and chemistry for the examination on "gases":

- Examination objective 2.1: Gases: partial pressures and mixtures. Definitions and simple calculations
- Examination objective 2.2: Gases: partial pressures and mixtures. Pressure increase and gas release from cargo tanks

[1] Distributed in German by the Central Commission for the Navigation of the Rhine under the symbol CCNR/ZKR/ADN/WP.15/AC.2/2009/34.

- Examination objective 3.1: Avogadro's number and calculation of masses of ideal gas – kmol, kg and pressure at 15° C
- Examination objective 3.2: Avogadro's number and calculation of masses of ideal gas. Application of the mass formula

Knowledge of physics and chemistry

Examination objective 2.1: Gases: partial pressures and mixtures

Definitions and simple calculations

Number	*Source*	*Correct answer*
G 2101	Partial pressure – definitions	B
	What is the definition of the partial pressure of a gas in a gas mixture contained in a cargo tank?	
	A The pressure indicated on the pressure gauge	
	B The pressure the gas would have if that gas alone were contained in the cargo tank	
	C The volume that gas alone would occupy	
	D The difference between the pressure of that gas and the atmospheric pressure	
G 2102	Partial pressure – definitions	C
	What is the definition of the partial pressure of a gas in a gas mixture contained in a cargo tank?	
	A The gauge pressure +1 bar	
	B The volume of that gas at atmospheric pressure	
	C The pressure the gas would have if that gas alone were contained in the cargo tank	
	D The difference between the pressure in the cargo tank and the atmospheric pressure	
G 2103	$p_{tot} = \sum p_i$ and Vol.-% $= p_i \times 100 / p_{tot}$	D
	A cargo tank contains a mixture of nitrogen and propane. The volume per cent of nitrogen is 20 and the volume per cent of propane is 80. The total absolute pressure in the cargo tank is 5.0 bar (absolute). What is the partial pressure of the propane?	
	A 0.2 bar (absolute)	
	B 0.8 bar (absolute)	
	C 3.2 bar (absolute)	
	D 4.0 bar (absolute)	
G 2104	$p_{tot} = \sum p_i$ and Vol.-% $= p_i \times 100 / p_{tot}$	C
	A cargo tank contains a mixture of nitrogen and propane. The nitrogen has a partial pressure of 1.0 bar (absolute) and its volume per cent is 20. What is the partial pressure of the propane?	

Number	*Source*	*Correct answer*
	A 0.8 bar (absolute)	
	B 3.2 bar (absolute)	
	C 4.0 bar (absolute)	
	D 5.0 bar (absolute)	
G 2105	$p_{tot} = \sum p_i$ and Vol.-% $= p_i \times 100 / p_{tot}$	B
	A gas mixture composed of 70 volume per cent propane and 30 volume per cent butane is contained in a cargo tank, at a gauge overpressure of 9 bar (gauge). What is the partial pressure of the butane?	
	A 2.7 bar (absolute)	
	B 3.0 bar (absolute)	
	C 6.3 bar (absolute)	
	D 7.0 bar (absolute)	
G 2106	deleted	
G 2107	$p_{tot} = \sum p_i$ and Vol.-% $= p_i \times 100 / p_{tot}$	B
	A gas mixture composed of propane and butane is contained in a cargo tank, at an overpressure of 9 bar (gauge). The partial pressure of the propane is 7.0 bar (absolute). What is the volume per cent of the butane?	
	A 20 volume per cent	
	B 30 volume per cent	
	C 40 volume per cent	
	D 60 volume per cent	
G 2108	$p_{tot} = \sum p_i$ and Vol.-% $= p_i \times 100 / p_{tot}$	C
	A gas mixture composed of propane, butane and isobutane is contained in a cargo tank, at an absolute pressure of 10 bar (absolute). The partial pressures of the butane and isobutane are 2 bar (absolute) and 3 bar (absolute) respectively. What is the volume per cent of the propane?	
	A 30 volume per cent	
	B 40 volume per cent	
	C 50 volume per cent	
	D 60 volume per cent	

Number	*Source*	*Correct answer*
G 2109	$p_{tot} = \sum p_i$ and Vol.-% $= p_i \times 100 / p_{tot}$ In a nitrogen/oxygen mixture at an absolute pressure of 20 bar (absolute), the partial pressure of the oxygen is 1 bar (absolute). What is the volume per cent of the nitrogen? A 86 volume per cent B 90 volume per cent C 90.5 volume per cent D 95 volume per cent	D

Knowledge of physics and chemistry

Examination objective 2.2: Gases: partial pressures and mixtures

Pressure increase and gas release from cargo tanks

Number	*Source*	*Correct answer*
G 2201	$p_{tot} = \sum p_i$ and Vol.-% $= p_i \times 100 / p_{tot}$ and $p * V$ = constant	B
	A cargo tank contains a gas mixture composed of 80 volume per cent propane and 20 volume per cent butane at an absolute pressure of 5 bar (absolute). After pressure relief of cargo tanks (gauge pressure = 0), the absolute pressure in the tank is increased to 4 bar (absolute). What is the volume per cent of the propane now?	
	A 16 volume per cent	
	B 20 volume per cent	
	C 25 volume per cent	
	D 32 volume per cent	
G 2202	$p_{tot} = \sum p_i$ and Vol.-% $= p_i \times 100 / p_{tot}$ and $p * V$ = constant	D
	A cargo tank with a volume of 300 m^3 contains isobutane at an overpressure of 0.5 bar (gauge). 900 m^3 of propane is then also compressed into the tank. What is the volume per cent of the isobutane now?	
	A 11.1 volume per cent	
	B 14.3 volume per cent	
	C 20.0 volume per cent	
	D 33.3 volume per cent	
G 2203	$p_{tot} = \sum p_i$ and Vol.-% $= p_i \times 100 / p_{tot}$ and $p * V$ = constant	B
	A cargo tank with a volume of 100 m^3 contains a gas mixture composed of 50 volume per cent propane and 50 volume per cent propylene, at an overpressure of 5 bar (gauge). At constant pressure, 600 m^3 of nitrogen is then also compressed into the tank at an absolute pressure of 1 bar (absolute). What is the volume per cent of the propane now?	
	A 23 volume per cent	
	B 25 volume per cent	
	C 27 volume per cent	
	D 30 volume per cent	

Number	*Source*	*Correct answer*
G 2204	$p_{tot} = \sum p_i$ and Vol.-% = p_i x 100/ p_{tot} and $p * V$ = constant In a cargo tank filled with air (20 volume per cent oxygen), the gauge pressure of 0.20 bar is increased, using nitrogen, to a gauge pressure of 5.0 bar. What is the partial pressure of the oxygen in the cargo tank? A 0.001 bar (absolute) B 0.040 bar (absolute) C 0.048 bar (absolute) D 0.240 bar (absolute)	D
G 2205	$p_{tot} = \sum p_i$ and Vol.-% = p_i x 100/ p_{tot} and $p * V$ = constant In a cargo tank filled with nitrogen there is low absolute pressure of 0.5 bar (absolute). An orifice is opened, and outside air containing 20 per cent oxygen enters. What is the partial pressure of the oxygen in the cargo tank? A 0.1 bar (absolute) B 0.2 bar (absolute) C 0.4 bar (absolute) D 1.0 bar (absolute)	A
G 2206	$p_{tot} = \sum p_i$ and Vol.-% = p_i x 100/ p_{tot} and $p * V$ = constant A cargo tank contains propane at an overpressure of 0.5 bar (gauge). Using nitrogen, the pressure in the cargo tank is increased to 5 bar (gauge). What is the volume per cent of the propane? A 8 volume per cent B 10 volume per cent C 25 volume per cent D 30 volume per cent	C
G 2207	$p_{tot} = \sum p_i$ and Vol.-% = p_i x 100/ p_{tot} and $p * V$ = constant A cargo tank with a volume of 100 m^3 contains propane at an overpressure of 0.5 bar (gauge). Using 450 m^3 of nitrogen, pressure is increased to an overpressure of 1 bar (gauge). What is the volume per cent of the propane? A 8 volume per cent B 10 volume per cent C 25 volume per cent D 30 volume per cent	C

Knowledge of physics and chemistry

Examination objective 3.1: Avogadro's number and calculation of masses of ideal gas kmol, kg and pressure at 15° C

Number	*Source*	*Correct answer*
G 3101	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	B
	A cargo tank has a volume of 72 m^3. The tank contains 12 kmol of an ideal gas at a temperature of 15 °C. What is the pressure?	
	A 3 bar (absolute)	
	B 4 bar (absolute)	
	C 5 bar (absolute)	
	D 6 bar (absolute)	
G 3102	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	A
	A cargo tank has a volume of 120 m^3. The tank contains 10 kmol of an ideal gas at a temperature of 15° C. What is the pressure?	
	A 2 bar (absolute)	
	B 4 bar (absolute)	
	C 5 bar (absolute)	
	D 12 bar (absolute)	
G 3103	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	B
	A cargo tank has a volume of 120 m^3. The tank contains a certain quantity of an ideal gas at a temperature of 15° C and at an absolute pressure of 3 bar (absolute). What is the quantity of gas?	
	A 5 kmol	
	B 15 kmol	
	C 20 kmol	
	D 30 kmol	
G 3104	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	A
	In a cargo tank, there is a leakage of 120 m^3 of gas UN No. 1978 PROPANE (M=44) at a pressure of 1 bar and at a temperature of 15° C. How many kg of propane gas leak into the atmosphere?	

Number	*Source*	*Correct answer*
	A 220 kg	
	B 440 kg	
	C 2,880 kg	
	D 5,280 kg	
G 3105	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	B
	A cargo tank has a volume of 240 m^3. How much gas UN No. 1969 ISOBUTANE (M=58) is there in the cargo tank when the temperature is 15° C and the absolute pressure is 2 bar (absolute)?	
	A 580 kg	
	B 1,160 kg	
	C 1,740 kg	
	D 4,640 kg	
G 3106	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	C
	A cargo tank has a volume of 240 m^3. How much gas UN No. 1978 PROPANE (M=42) is there in the cargo tank when the temperature is 15° C and the absolute pressure is 3 bar (absolute)?	
	A 210 kg	
	B 420 kg	
	C 630 kg	
	D 840 kg	
G 3107	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	B
	A cargo tank has a volume of 120 m^3. The tank contains 440 kg of gas UN No. 1978 PROPANE (M=44) at a temperature of 15° C. What is the pressure?	
	A 1 bar (absolute)	
	B 2 bar (absolute)	
	C 11 bar (absolute)	
	D 12 bar (absolute)	
G 3108	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	D
	A cargo tank with a volume of 100 m^3 contains 30 kmol of gas UN No. 1978 PROPANE at a temperature of 15° C. What is the maximum quantity (m^3) of propane gas at an absolute pressure of 1 bar (absolute) that could leak?	
	A 180 m^3	
	B 380 m^3	

Number	*Source*	*Correct answer*
	C 420 m^3	
	D 620 m^3	
G 3109	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	C
	A cargo tank contains 10 kmol of an ideal gas at a temperature of 15° C and an absolute pressure of 5 bar (absolute). What is the volume of the cargo tank?	
	A 12 m^3	
	B 40 m^3	
	C 48 m^3	
	D 60 m^3	
G 3110	1 kmol ideal gas = M kg = 24 m^3 at 1 bar and 15° C	C
	A cargo tank has a volume of 288 m^3. The tank contains an ideal gas at an absolute pressure of 4 bar (absolute). What is the quantity of gas in the cargo tank?	
	A 24 kmol	
	B 36 kmol	
	C 48 kmol	
	D 60 kmol	

Knowledge of physics and chemistry

Examination objective 3.2: Avogadro's number and calculation of masses of ideal gas

Application of the mass formula

Number	*Source*	*Correct answer*
G 3201	$m = 12 * p * M * V / T$	B
	A cargo tank has a volume of 200 m^3. What quantity (kg) of UN No. 1005 AMMONIA, ANHYDROUS (M=17) is in the tank when the temperature is 40° C and the absolute pressure is 3 bar (absolute)?	
	A 261 kg	
	B 391 kg	
	C 2,040 kg	
	D 3,060 kg	
G 3202	$m = 12 * p * M * V / T$	A
	A cargo tank has a volume of 100 m^3. What quantity (kg) of UN No. 1010 BUTADIENES-1-2, STABILIZED (M=54) is in the tank when the temperature is 30° C and the absolute pressure is 2 bar (bar absolute)?	
	A 428 kg	
	B 642 kg	
	C 4,320 kg	
	D 6,480 kg	
G 3203	$m = 12 * p * M * V / T$	B
	A cargo tank has a volume of 100 m^3. What quantity (kg) of UN 1978 PROPANE (M=44) is in the tank when the temperature is 20° C and the absolute pressure is 3 bar (absolute)?	
	A 360 kg	
	B 541 kg	
	C 5,280 kg	
	D 7,920 kg	
G 3204	$m = 12 * p * M * V / T$	C
	A cargo tank has a volume of 200 m^3. What quantity (kg) of UN 1077 PROPYLENE (M=42) is in the tank when the temperature is -5° C and the absolute pressure is 2 bar (absolute)?	
	A 376 kg	
	B 725 kg	

Number	*Source*	*Correct answer*
	C 752 kg	
	D 1,128 kg	
G 3205	$m = 12 * p * M * V / T$	A
	A cargo tank has a volume of 200 m^3. What quantity (kg) of UN 1969 ISOBUTANE (M=56) is in the tank when the temperature is 40° C and the absolute pressure is 4 bar (absolute)?	
	A 1,718 kg	
	B 2,147 kg	
	C 10,080 kg	
	D 12,600 kg	
G 3206	$m = 12 * p * M * V / T$ or $p = m * T / (12 * M * V)$	D
	A cargo tank has a volume of 300 m^3. The tank contains 2,640 kg of gas UN No. 1978 PROPANE (M=44) at a temperature of 7° C. What is the pressure in the cargo tank?	
	A 0.1 bar (absolute)	
	B 1.1 bar (absolute)	
	C 3.0 bar (absolute)	
	D 4.0 bar (absolute)	
G 3207	$m = 12 * p * M * V / T$ or $p = m * T / (12 * M * V)$	D
	A cargo tank has a volume of 100 m^3. The tank contains 1,176 kg of gas UN No. 1077 PROPYLENE (M=42) at a temperature of 27° C. What is the pressure in the cargo tank?	
	A 0.6 bar (absolute)	
	B 1.9 bar (absolute)	
	C 6.0 bar (absolute)	
	D 7.0 bar (absolute)	
G 3208	$m = 12 * p * M * V / T$ or $p = m * T / (12 * M * V)$	C
	A cargo tank has a volume of 450 m^3. The tank contains 1,700 kg of gas UN No. 1005 AMMONIA (M=17) at a temperature of 27° C. What is the pressure in the cargo tank?	
	A 0.5 bar (absolute)	
	B 1.5 bar (absolute)	
	C 5.6 bar (absolute)	
	D 6.6 bar (bar absolute)	
G 3209	$m = 12 * p * M * V / T$ or $p = m * T / (12 * M * V)$	D
	A cargo tank has a volume of 250 m^3. The tank contains 1,160 kg of gas UN No. 1011 BUTANE (M=58) at a	

Number	*Source*	*Correct answer*
	temperature of 27° C. What is the pressure in the cargo tank? A 0.2 bar (absolute) B 1.0 bar (absolute) C 1.2 bar (absolute) D 2.0 bar (absolute)	
G 3210	$m = 12 * p * M * V / T$ or $p = m * T / (12 * M * V)$ A cargo tank has a volume of 200 m^3. The tank contains 2,000 kg of gas UN No. 1068 VINYL CHLORIDE (M=62.5) at a temperature of 27° C. What is the pressure in the cargo tank? A 0.4 bar (absolute) B 1.4 bar (absolute) C 3.0 bar (absolute) D 4.0 bar (absolute)	D