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CHEMISTRY
STANDARD LEVEL
PAPER 1

Tuesday 8 May 2012 (afternoon)

45 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The periodic table is provided for reference on page 2 of this examination paper.
- The maximum mark for this examination paper is *[30 marks]*.

The Periodic Table

1	2											3	4	5	6	7	0
1 **H** 1.01																	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.37	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.40	49 **In** 114.82	50 **Sn** 118.69	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
55 **Cs** 132.91	56 **Ba** 137.34	57 † **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.21	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.19	83 **Bi** 208.98	84 **Po** (210)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ‡ **Ac** (227)															

†	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** 146.92	62 **Sm** 150.35	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.92	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
‡	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (242)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (254)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

1. What is the total number of atoms in 0.100 mol of $[Pt(NH_3)_2Cl_2]$?

A. 11

B. 6.02×10^{22}

C. 3.01×10^{23}

D. 6.62×10^{23}

2. Nitroglycerine, $C_3H_5N_3O_9$, can be used in the manufacture of explosives. What is the coefficient of $C_3H_5N_3O_9(l)$ when the equation for its decomposition reaction is balanced using the lowest whole numbers?

$$\_\_\_\ C_3H_5N_3O_9(l) \rightarrow \_\_\_\ CO_2(g) + \_\_\_\ H_2O(l) + \_\_\_\ N_2(g) + \_\_\_\ O_2(g)$$

A. 2

B. 4

C. 20

D. 33

3. The volume occupied by one mole of an ideal gas at 273 K and 1.01×10^5 Pa is 22.4 dm^3. What volume, in dm^3, is occupied by 3.20 g $O_2(g)$ at 273 K and 1.01×10^5 Pa?

A. 2.24

B. 4.48

C. 22.4

D. 71.7

4. What volume, in m^3, is occupied by 2.00 mol of gas at $27\ ^\circ C$ and 2.00 atm pressure? Assume: $1.00\ atm = 1.01\times10^5\ Pa$ and $R = 8.31\ J\ K^{-1}\ mol^{-1}$.

A. $\frac{8.31\times27}{1.01\times10^5}$

B. $\frac{2.00\times8.31\times27}{1.01\times10^5}$

C. $\frac{2.00\times8.31\times300}{2.00\times1.01\times10^5}$

D. $\frac{2.00\times8.31\times300}{1.01\times10^5}$

5. Which statements about solutions are correct?

I. A solute dissolves in a solvent to form a solution.

II. A solution is a homogeneous mixture of two or more substances.

III. Concentrations of solutions can be expressed in $g\,dm^{-3}$.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

6. Which subatomic particles are located in the nucleus of an atom?

A. Protons and electrons

B. Neutrons and electrons

C. Protons and neutrons

D. Protons, neutrons and electrons

7. What is the name of the type of spectrum consisting only of specific wavelengths?

A. Electromagnetic

B. Continuous

C. Line

D. Mass

8. Which statements are correct for silicon?

I. Its electron arrangement is 2,8,4.

II. It has four electrons in its highest occupied energy level.

III. In the solid state, each silicon atom is covalently bonded to four other silicon atoms in a tetrahedral arrangement.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

9. Which series is correctly arranged in order of **decreasing** radius?

A. $Al^{3+} > Mg^{2+} > Na^{+} > F^{-}$

B. $F^{-} > Na^{+} > Mg^{2+} > Al^{3+}$

C. $F^{-} > Al^{3+} > Mg^{2+} > Na^{+}$

D. $Na^{+} > Mg^{2+} > Al^{3+} > F^{-}$

10. What is the formula of magnesium nitride?

A. Mg_2N_3

B. Mg_3N_2

C. $Mg(NO_3)_2$

D. $Mg(NO_2)_2$

11. Which single covalent bond is the most polar, given the following electronegativity values?

Element	H	C	S	O
Electronegativity	2.2	2.6	2.6	3.4

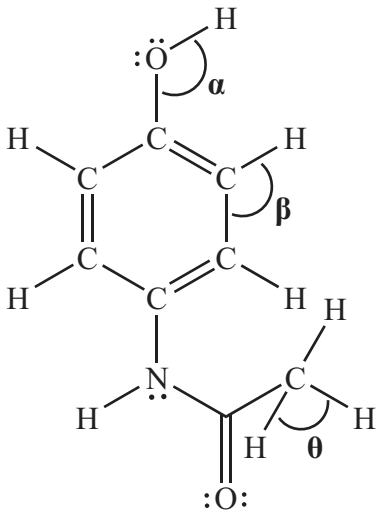
A. C–O

B. S–H

C. C–H

D. O–H

12. The Lewis (electron dot) structure of paracetamol (acetaminophen) is:



What are the approximate values of the bond angles?

	α	β	θ
A.	104.5°	120°	109.5°
B.	109.5°	109.5°	109.5°
C.	120°	120°	90°
D.	104.5°	120°	90°

13. C_{60} fullerene consists of a simple molecular structure. Silicon dioxide, SiO_2, can be described as a giant covalent (macromolecular) structure. Which statements are correct?

I. Each carbon atom in C_{60} fullerene is bonded in a sphere of 60 carbon atoms, consisting of pentagons and hexagons.

II. Each O–Si–O bond angle in SiO_2 is 180°.

III. SiO_2 is insoluble in water.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

14. Which types of intermolecular forces exist in HBr, Cl_2 and CH_3F?

	HBr	**Cl_2**	**CH_3F**
A.	van der Waals' and dipole-dipole	van der Waals' only	van der Waals' and dipole-dipole
B.	van der Waals' and dipole-dipole	van der Waals' only	van der Waals', dipole-dipole and hydrogen bonding
C.	van der Waals' only	van der Waals' only	van der Waals', dipole-dipole and hydrogen bonding
D.	van der Waals' and dipole-dipole	van der Waals' and dipole-dipole	van der Waals', dipole-dipole and hydrogen bonding

15. A simple calorimeter was set up to determine the enthalpy change occurring when one mole of ethanol is combusted. The experimental value was found to be –867 kJ mol^{-1}. The Data Booklet value is –1367 kJ mol^{-1} (at 298 K and 1.01×10^5 Pa).

During the experiment some black soot formed.

Which statements are correct?

I. The percentage error for the experiment can be calculated as follows:

$$(1367-867)\times100\,\%$$

II. The difference between the two values may be due to heat loss to the surroundings.

III. The black soot suggests that incomplete combustion occurred.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

16. Consider the equations:

$$N_2(g) + 2H_2(g) \rightarrow N_2H_4(l) \qquad \Delta H^{\ominus} = +50.6 \text{ kJ mol}^{-1}$$

$$N_2H_4(l) \rightarrow N_2H_4(g) \qquad \Delta H^{\ominus} = +44.8 \text{ kJ mol}^{-1}$$

What is $\Delta H^{\ominus}$, in kJ, for the following reaction?

$$N_2(g) + 2H_2(g) \rightarrow N_2H_4(g)$$

A. -95.4

B. -5.80

C. $+5.80$

D. $+95.4$

17. Which are appropriate units for the rate of a reaction?

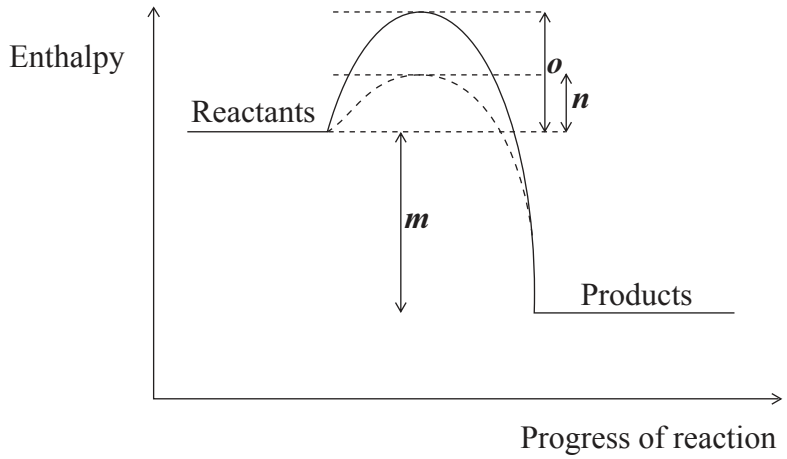
A. $\text{mol dm}^{-3}\ \text{s}^{-1}$

B. $\text{mol dm}^{-3}\ \text{s}$

C. mol dm^{-3}

D. s

18. The following enthalpy level diagram shows the effect of the addition of a catalyst on a chemical reaction. What do ***m***, ***n*** and ***o*** represent?



	m	***n***	***o***
A.	ΔH	E_a (without a catalyst)	E_a (with a catalyst)
B.	E_a (with a catalyst)	ΔH	E_a (without a catalyst)
C.	E_a (with a catalyst)	E_a (without a catalyst)	ΔH
D.	ΔH	E_a (with a catalyst)	E_a (without a catalyst)

19. What is the equilibrium constant expression, K_c, for the following reaction?

$$2\text{NOBr}(g) \rightleftharpoons 2\text{NO}(g) + \text{Br}_2(g)$$

A. $K_c = \dfrac{[\text{NO}][\text{Br}_2]}{[\text{NOBr}]}$

B. $K_c = \dfrac{[\text{NO}]^2[\text{Br}_2]}{[\text{NOBr}]^2}$

C. $K_c = \dfrac{2[\text{NO}]+[\text{Br}_2]}{[2\text{NOBr}]}$

D. $K_c = \dfrac{[\text{NOBr}]^2}{[\text{NO}]^2[\text{Br}_2]}$

20. What happens to the position of equilibrium and the value of K_c when the temperature is increased in the following reaction?

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g) \qquad \Delta H^{\ominus} = +87.9 \text{ kJ mol}^{-1}$$

	Position of equilibrium	Value of K_c
A.	shifts towards reactants	decreases
B.	shifts towards reactants	increases
C.	shifts towards products	decreases
D.	shifts towards products	increases

21. What is the Brønsted–Lowry conjugate base of $H_2PO_4^-$?

A. H_3PO_4

B. HPO_4^{2-}

C. PO_4^{3-}

D. HO^-

22. Three aqueous solutions of nitric acid are listed below.

W. 0.100 mol dm^{-3} $HNO_3(aq)$

X. 0.001 mol dm^{-3} $HNO_3(aq)$

Y. 0.010 mol dm^{-3} $HNO_3(aq)$

What is the correct order of **increasing** pH of these solutions?

A. W < X < Y

B. W < Y < X

C. X < W < Y

D. X < Y < W

23. What is the name of Cu_2S?

A. Copper(I) sulfide

B. Copper(I) sulfate

C. Copper(II) sulfide

D. Copper(II) sulfate

24. Consider the following reaction:

$$3Sn^{2+}(aq) + Cr_2O_7^{2-}(aq) + 2H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3SnO_2(s) + H_2O(l)$$

Which statement is correct?

A. Sn^{2+} is the oxidizing agent because it undergoes oxidation.

B. Sn^{2+} is the reducing agent because it undergoes oxidation.

C. $Cr_2O_7^{2-}$ is the oxidizing agent because it undergoes oxidation.

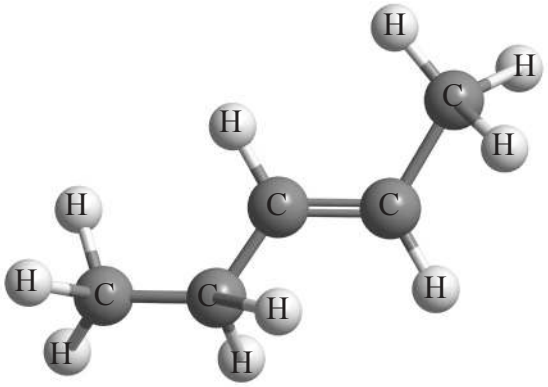
D. $Cr_2O_7^{2-}$ is the reducing agent because it undergoes oxidation.

25. What occurs during the operation of a voltaic cell based on the following overall reaction?

$$2Ag^+(aq) + Cu(s) \rightarrow 2Ag(s) + Cu^{2+}(aq)$$

	External circuit	**Ion movement in solution**
A.	electrons move from Cu(s) to Ag(s)	$Ag^+(aq)$ move towards Cu(s)
B.	electrons move from Ag(s) to Cu(s)	$Ag^+(aq)$ move towards Ag(s)
C.	electrons move from Cu(s) to Ag(s)	$Ag^+(aq)$ move towards Ag(s)
D.	electrons move from Ag(s) to Cu(s)	$Cu^{2+}(aq)$ move towards Cu(s)

26. Consider the compound $(CH_3CH_2)CH=CH(CH_3)$. Which statements are correct?



I. A suitable name is pent-2-ene.

II. The empirical formula is CH_2.

III. An isomer of the compound is pentane.

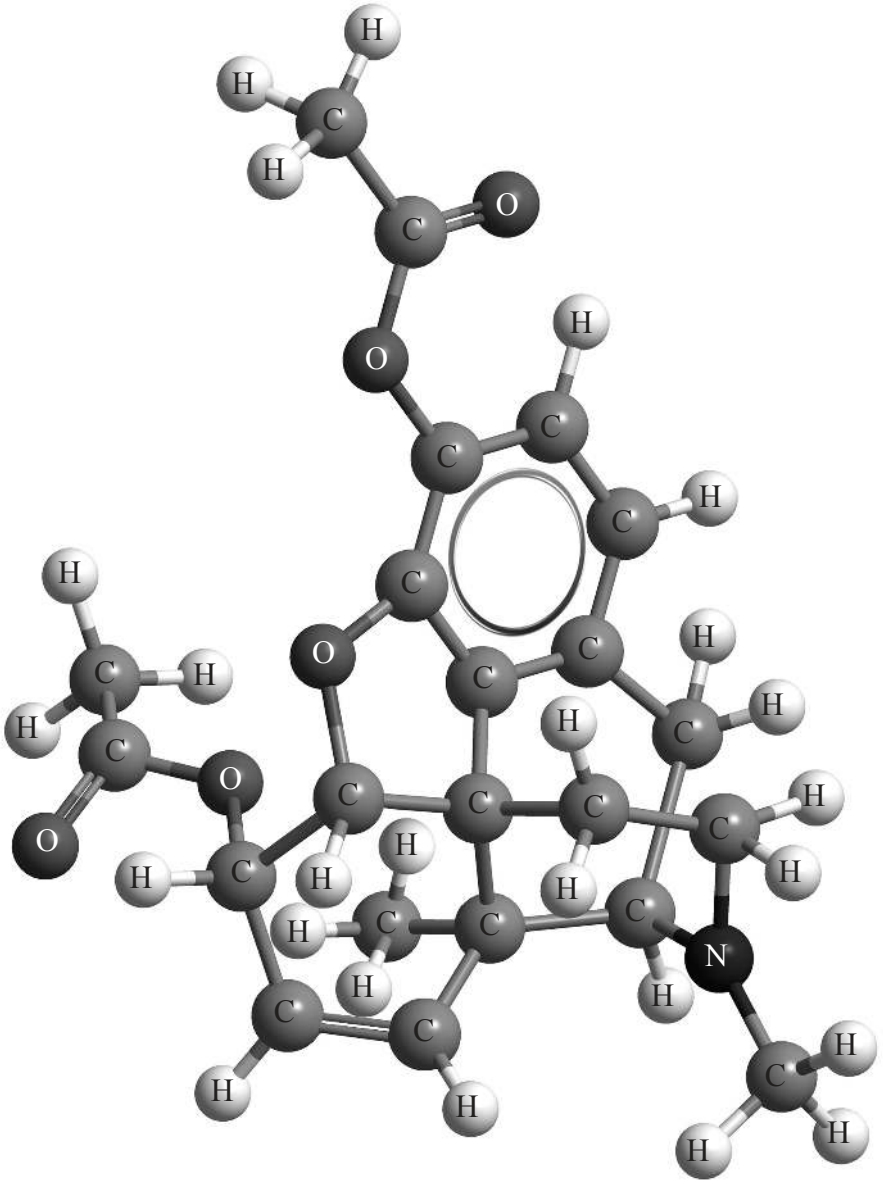
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

27. Diamorphine (heroin) contains several different functional groups. Which of the following two functional groups are present in diamorphine?



A. ester, benzene ring

B. ketone, benzene ring

C. aldehyde, alkene

D. ketone, alkene

28. Which compound has the **lowest** boiling point?

A. $CH_3CH_2CH_2OH$

B. $CH_3CH_2CH_2Br$

C. CH_3CH_2COOH

D. $CH_3CH_2CH_2CH_3$

29. Which organic compounds, **Q** and **P**, are formed in the following two-stage reaction pathway?

Stage 1: $CH_3(CH_2)_3Cl \xrightarrow[\text{heat}]{\text{NaOH(aq)}}$ **Q**

Stage 2: **Q** $\xrightarrow[\text{reflux}]{Cr_2O_7^{2-}(aq)/H^+(aq)}$ **P**

	Q	**P**
A.	$CH_3(CH_2)_3OH$	$CH_3(CH_2)_3COOH$
B.	$CH_3(CH_2)_3OH$	$CH_3(CH_2)_2COOH$
C.	$CH_3CH_2CH{=}CH_2$	no reaction product formed
D.	$CH_3(CH_2)_3OH$	$CH_3(CH_2)_2CHO$

30. The relationship between the pressure, P, and the volume, V, of a fixed amount of gas at a constant temperature is investigated experimentally. Which statements are correct?

I. A graph of V against P will be a curve (non-linear).

II. A graph of V against $\frac{1}{P}$ will be linear.

III. $V = \text{constant} \times \frac{1}{P}$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III