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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)																

Atomic number / Element / Relative atomic mass

† | 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. How many atoms of hydrogen are in 0.500 mol of CH_3OH molecules?

   A. 1.20×10^{23}

   B. 3.01×10^{23}

   C. 6.02×10^{23}

   D. 1.20×10^{24}

2. 1 mol of a hydrocarbon with general formula C_nH_{2n+2} reacts completely with oxygen to produce 4 mol of H_2O. What is the amount of oxygen molecules, in mol, that reacts?

   A.   4

   B.   5

   C.   6

   D.   7

3. Under which combination of conditions is 1 mol of an ideal gas present?

	Volume	Pressure	Temperature
A.	22.4 dm^3	101 Pa	273 K
B.	22.4 m^3	101 Pa	298 K
C.	22.4 dm^3	101 kPa	273 K
D.	22.4 m^3	101 kPa	298 K

4. A fixed mass of an ideal gas at $27.0\,°C$ and $1.01 \times 10^5\,Pa$ has a volume of $100\,cm^3$. Which change doubles the volume of the gas?

   A.   Heating the gas at constant pressure to $54.0\,°C$.

   B.   Heating the gas at constant pressure to $327\,°C$.

   C.   Increasing the pressure on the gas to $2.02 \times 10^5\,Pa$ at constant temperature.

   D.   Heating the gas to $54.0\,°C$ and increasing the pressure to $2.02 \times 10^5\,Pa$.

5. $10\,cm^3$ of a solution of $1.0\,mol\,dm^{-3}$ NaOH (aq) is diluted with water until the final volume is $100\,cm^3$. What is the concentration, in $mol\,dm^{-3}$, of the new solution?

   A.   0.10

   B.   1.0

   C.   10.0

   D.   0.01

6. Which isotope has an atomic number of 9 and a mass number of 19?

   A. ^9F

   B. ^{19}K

   C. ^{19}F

   D. ^{28}Si

7. An ^{16}O atom, an $^{16}O^+$ ion and an $^{18}O^+$ ion, all travelling at the same velocity, enter into the magnetic field of a mass spectrometer. Which is the path of each of the particles?
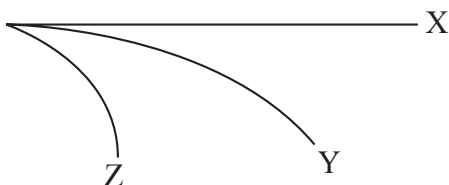
	^{16}O	$^{16}O^+$	$^{18}O^+$
A.	X	Y	Z
B.	Y	Z	X
C.	X	Z	Y
D.	Z	X	Y

8. Which sequence of elements is in order of **increasing** electronegativity?

A.   Li < Na < Rb

B.   O < N < C

C.   F < Cl < Br

D.   Si < P < S

9. Which combination of descriptions is correct for the oxides of period 3 elements?

	Chlorine	**Magnesium**	**Silicon**	**Sodium**
A.	basic	acidic	basic	acidic
B.	acidic	basic	basic	basic
C.	basic	acidic	acidic	acidic
D.	acidic	basic	acidic	basic

2212-6110   **Turn over**

10. Which substance has the greatest bond length between the carbon atoms?

    A. C_2H_2

    B. C_2H_4

    C. C_2H_6

    D. C_2Cl_4

11. Which substance has a high melting point and conducts electric current in the solid state?

    A.   Potassium

    B.   Potassium chloride

    C.   Graphite

    D.   Silicon dioxide

12. Which statement about intermolecular forces is correct?

    A.   The intermolecular force between H_2 molecules is hydrogen bonding, because H_2 has temporary dipoles.

    B.   The intermolecular forces between PH_3 molecules are greater than the intermolecular forces between NH_3 molecules, because they have a greater mass.

    C.   The intermolecular force between H_2 molecules is hydrogen bonding, because H_2 has permanent dipoles.

    D.   The intermolecular forces between Br_2 molecules are van der Waals', because Br_2 has temporary dipoles.

13. Which substances are soluble in hexane, C_6H_{14}?

      I. C_8H_{18}

      II. CH_4

      III. H_2O

    A.   I and II only

    B.   I and III only
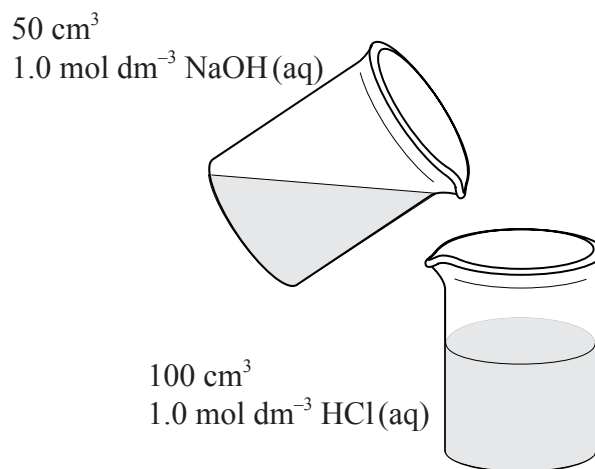
    C.   II and III only

    D.   I, II and III

14. What are the units for specific heat capacity?

    A. $kJ\ kg\ K$

    B. $kJ\ kg\ K^{-1}$

    C. $kJ\ kg^{-1}\ K$

    D. $kJ\ kg^{-1}\ K^{-1}$

15. In each of two different experiments, A and B, a solution of sodium hydroxide is added to a solution of hydrochloric acid. The initial temperature of each solution is $25\,°C$.
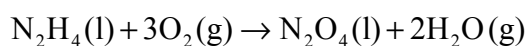
50 cm^3
1.0 mol dm^{-3} NaOH(aq)

50 cm^3
1.0 mol dm^{-3} NaOH(aq)

50 cm^3
1.0 mol dm^{-3} HCl(aq)

100 cm^3
1.0 mol dm^{-3} HCl(aq)
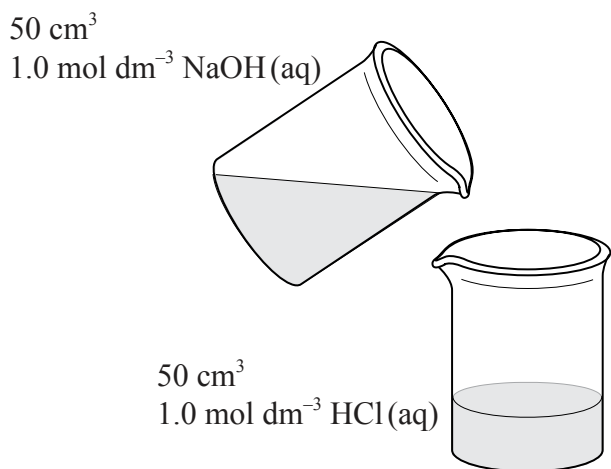
Experiment A   Experiment B

Which statement is correct?

A.   The highest recorded temperature of experiment A is lower than the highest recorded temperature of experiment B.

B.   The highest recorded temperature of both experiments is equal.

C.   The heat produced in experiment A is lower than the heat produced in experiment B.

D.   The heat produced in both experiments is equal.

16. The enthalpy changes, in kJ, for the following two reactions are x and y.

$$2N_2H_4(l) + N_2O_4(l) \rightarrow 3N_2(g) + 4H_2O(g) \qquad \Delta H^{\ominus} = x$$

$$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta H^{\ominus} = y$$
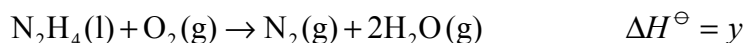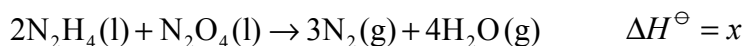
What is the enthalpy change, in kJ, for the reaction?

$$N_2H_4(l) + 3O_2(g) \rightarrow N_2O_4(l) + 2H_2O(g)$$

A. $x - y$
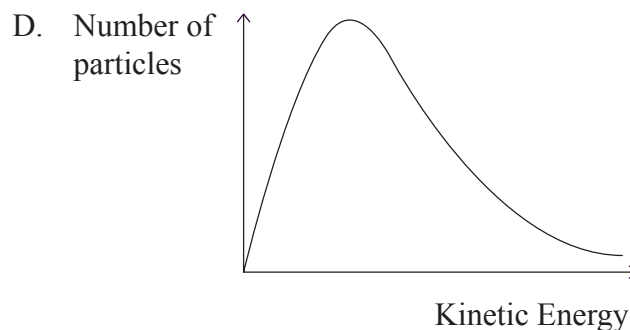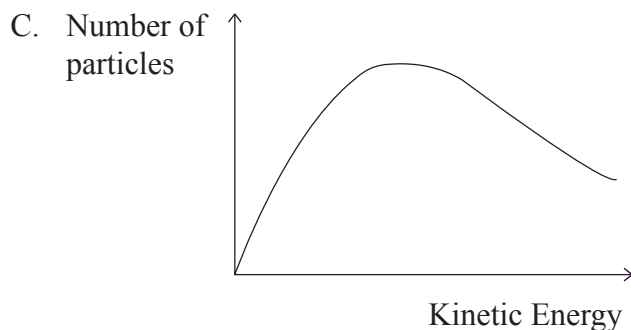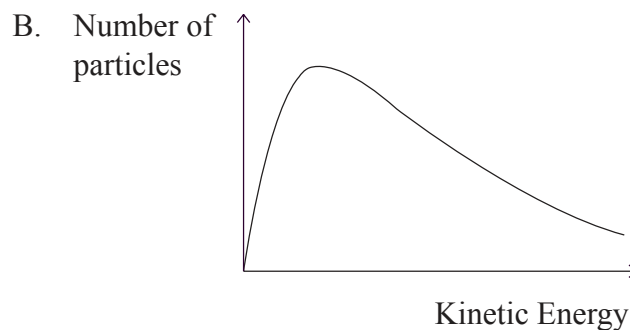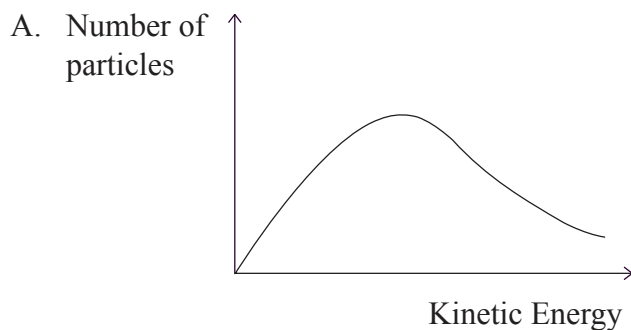
B. $y - x$

C. $3x - y$

D. $3y - x$

17. Identical pieces of calcium carbonate are added to two separate flasks containing excess 0.1 mol dm^{-3} hydrochloric acid at different temperatures. The masses of the contents of the flasks are monitored. Which graph represents the reaction at the higher temperature?

A.

B.

C.

D.

Turn over
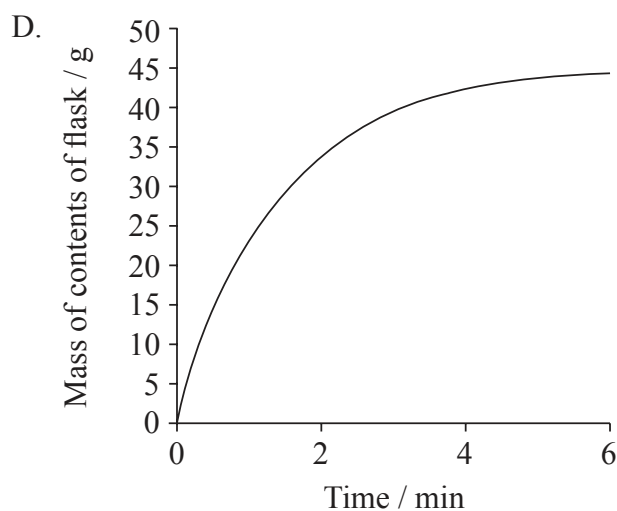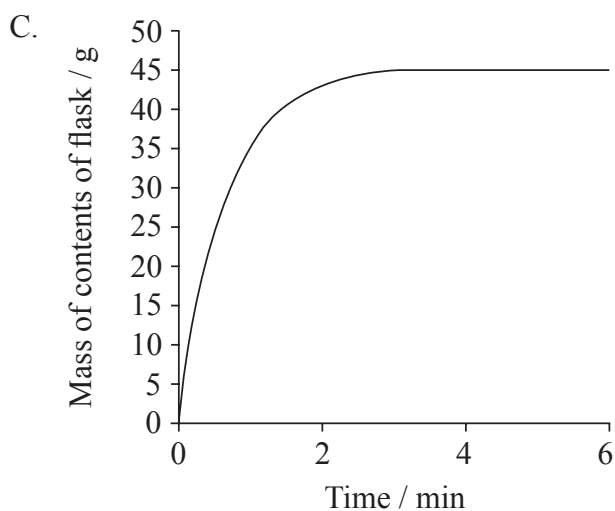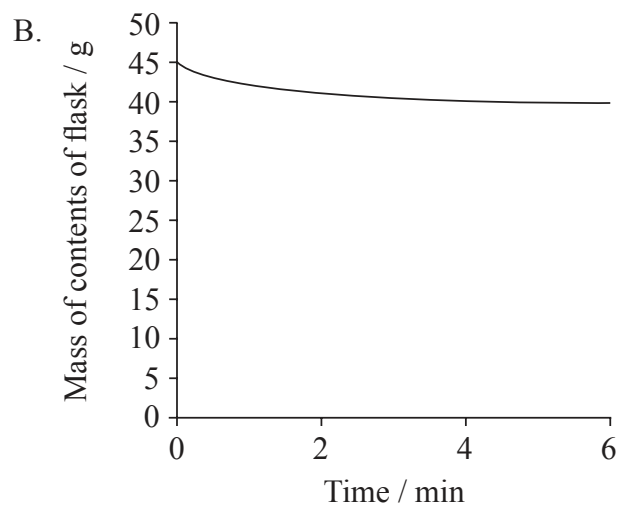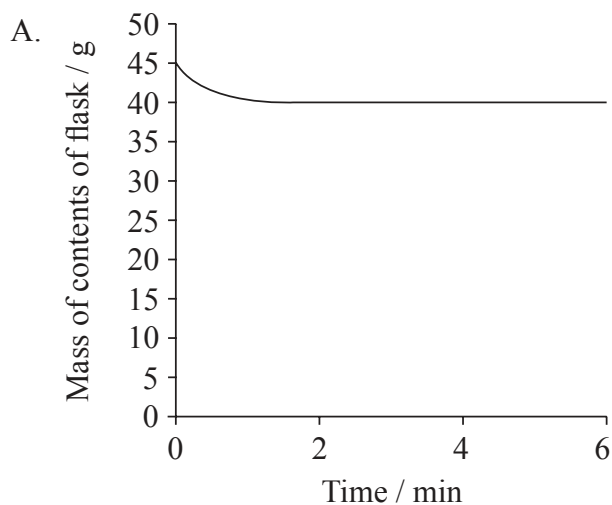
18. The Maxwell–Boltzmann curve below shows the distribution of kinetic energies for the particles in a sample of gas.

Number of
particles ↑

Kinetic Energy
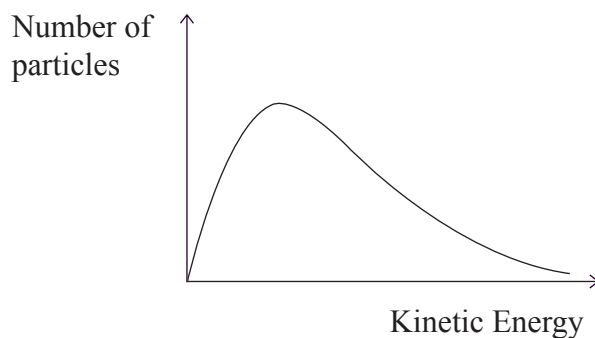
Which is the shape of the curve for the same sample of gas at a higher temperature? All graphs are drawn to the same scale.

A. Number of
particles ↑

Kinetic Energy

B. Number of
particles ↑

Kinetic Energy

C. Number of
particles ↑

Kinetic Energy

D. Number of
particles ↑

Kinetic Energy

19. The graph represents the rates of the forward and backward reactions of a reversible reaction.

Rate of reaction

X

W   Z

Y

Time
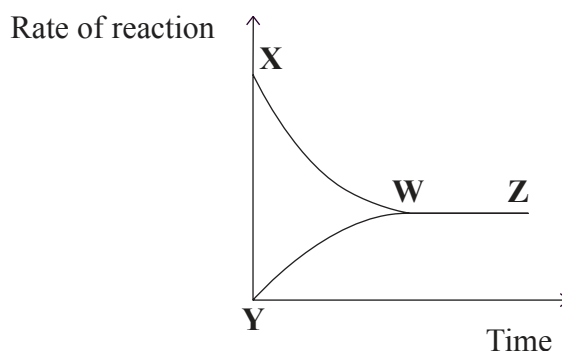
Which statement is correct?

A.   **XWZ** represents the rate of the forward reaction.

B.   At **Y**, the rate of the forward and backward reactions is zero.

C.   Between **W** and **Z**, the concentrations of products and reactants are equal.

D.   Between **Y** and **W**, the concentration of the reactants increases.

20. The production of sulfuric acid by the Contact process involves the following equilibrium.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H^{\ominus} = -196 \text{ kJ mol}^{-1}$$

Which statement about the process is correct?

A.   An increase in temperature would shift the equilibrium to the right.

B.   An increase in temperature would increase the rate of reaction.

C.   The presence of a catalyst would shift the equilibrium to the right.

D.   An increase in pressure would shift the equilibrium to the left.

21. Which are conjugate acid/base pairs according to the Brønsted–Lowry theory?

      I. NH_4^+/NH_3

      II. $HCOOH/HCOO^-$

      III. H_2SO_4/SO_4^{2-}

    A.   I and II only

    B.   I and III only

   C.   II and III only

    D.   I, II and III

22. $10\ cm^3$ of NaOH solution is diluted with an equal volume of water. Which shows correctly the changes in the concentration of hydroxide ions and the pH?

	$[OH^-]$	pH
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

23. What are the oxidation numbers of sulfur in the species below?

	SO_3^{2-}	$NaHSO_4$	H_2S
A.	+2	+6	+2
B.	+6	+4	+2
C.	+4	+6	−2
D.	+6	+2	−2

24. The equation for the redox reaction between acidified dichromate and iodide ions is shown below.

$$Cr_2O_7{}^{2-}(aq) + 6I^-(aq) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3I_2(aq) + 7H_2O(l)$$
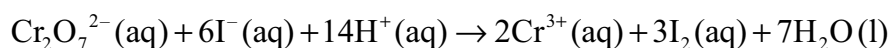
Which is the reduction half-equation?

A. $6I^-(aq) + 6e^- \rightarrow 3I_2(aq)$

B. $6I^-(aq) \rightarrow 3I_2(aq) + 6e^-$

C. $Cr_2O_7{}^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$

D. $Cr_2O_7{}^{2-}(aq) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) + 6e^-$

25. The equation for the overall reaction in a voltaic cell is:

$$Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$$
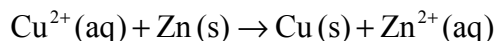
Which statements are correct for this cell?

I.   Cu is the positive electrode.

II.   Negative ions flow from the zinc solution to the copper solution.

III. Chemical energy is converted into electrical energy during this reaction.

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

26. How many isomers have the molecular formula C_5H_{12}?

A.   2

B.   3

C.   4

D.   5

Turn over

27. Which functional groups are present in this molecule?
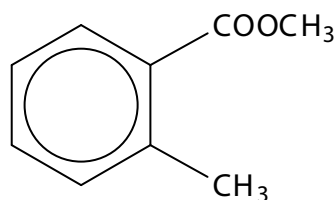
A.   Ester and methyl

B.   Ketone and methyl

C.   Benzene ring and ester

D.   Benzene ring and ketone

28. Which reaction of but-2-ene produces 2-chlorobutane?

A.   Addition reaction with chlorine

B.   Substitution reaction with hydrogen chloride

C.   Substitution reaction with chlorine

D.   Addition reaction with hydrogen chloride

29. What are the correct names of the reaction types shown?

$$CH_3CH_2CH_3 \xrightarrow{\text{I}} ClCH_2CH_2CH_3 \xrightarrow{\text{II}} HOCH_2CH_2CH_3$$

	I	II
A.	nucleophilic substitution	oxidation
B.	free-radical substitution	oxidation
C.	nucleophilic substitution	nucleophilic substitution
D.	free-radical substitution	nucleophilic substitution

30. A student measured the mass of a solid on an analytical balance during an internally assessed IB practical experiment and recorded the mass in his raw data. The accuracy of the balance, as stated by the manufacturers, was ± 0.01 g. Which of the following choices would be the best record of his mass?

A.   10.2 g

B.   10 g

C.   10.20 g

D.   10.200 g