IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

CHEMICAL AND PHYSICAL SYSTEMS
HIGHER LEVEL
PAPER 1

May 2002

1 hour

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.

Periodic Table

1 **H** 1.01				Atomic Number Atomic Mass													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)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs**	109 **Mt**									

†	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. The number of electrons in the ion $^{138}_{56}Ba^{2+}$ is

A. 54.

B. 56.

C. 82.

D. 138.

2. What numerical value of **y** is required to balance the following reaction between iron and air?

$$4\ Fe_{(s)} + \mathbf{y}\ O_{2(g)} + 2H_2O_{(l)} \rightarrow 4FeO(OH)_{(s)}$$

A. 1

B. 2

C. 3

D. 4

3. 0.2 moles of a substance has a mass of 8 g. The molar mass of the substance would be

A. $4\ g\,mol^{-1}$.

B. $8\ g\,mol^{-1}$.

C. $16\ g\,mol^{-1}$.

D. $40\ g\,mol^{-1}$.

4. A hydrocarbon contains 86 % carbon. Its empirical formula would be

A. C_2H_4.

B. CH_2.

C. C_2H.

D. C_2H_2.

5. Substance Y has the properties shown in the table below.

Melting point	**Boiling point**	**Electrical conductivity (molten)**	**Electrical conductivity (solid)**
98 °C	883 °C	Good	Good

Substance Y can only be

A. a network molecular substance.

B. a polar covalent substance.

C. an ionic compound.

D. a metallic element.

6. The element that would require the greatest amount of energy to remove a second electron after the previous removal of one electron would be

A. sodium.

B. silicon.

C. magnesium.

D. aluminium.

7. A student added 5 cm^3 of a 2 M solution of sodium hydroxide to a 500 cm^3 volumetric flask and the volume was then made up to the 500 cm^3 mark with water. The concentration of the final solution would be

A. 0.5 M.

B. 0.02 M.

C. 0.002 M.

D. 0.05 M.

8. When going across period 3 from sodium to chlorine, the correct trend that occurs in this period with increasing atomic number is

A. a decrease in the ionisation energy.

B. an increase in the acidity of the oxides.

C. a decrease in electronegativity.

D. a change from covalent to ionic chlorides.

9. For the reactions

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H = -393 \text{ kJ}$$
$$CO_{(g)} + \tfrac{1}{2}O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H = -283 \text{ kJ}.$$

What is ΔH for the following reaction?

$$C_{(s)} + \tfrac{1}{2}O_{2(g)} \rightarrow CO_{(g)}$$

A. – 110 kJ

B. – 676 kJ

C. + 110 kJ

D. + 676 kJ

10. Two molecules X and Y are successive members of a homologous series. They would have

A. the same molecular formula but different structural formulae.

B. the same ignition temperatures.

C. a difference in their molar masses of 14.

D. the same boiling point.

11. When the pH of 0.1 mol dm^{-3} solutions of arsenic acid (H_3AsO_4) and hydrochloric acid are measured, it is found that the values are:

arsenic acid (H_3AsO_4)	pH 1.6
hydrochloric acid	pH 1.0

This is because arsenic acid

A. is in the same group as phosphorus in the periodic table.

B. has more than one hydrogen that can react with a base.

C. does not completely dissociate in water.

D. is more acidic than hydrochloric acid.

12. Carbon dioxide is bubbled into water until a saturated solution is formed. Which of the following would be expected to have the highest concentration in the solution?

A. HCO_3^-

B. H_2CO_3

C. CO_3^{-2}

D. CO_2

13. In which of the following reactions would an increase in the pressure of oxygen lead to an increase in the rate of the reaction?

A. $2SO_{3(g)} \rightarrow 2SO_{2(g)} + O_{2(g)}$

B. $2Na_{(s)} + O_{2(g)} \rightarrow Na_2O_{2(s)}$

C. $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

D. $2H_2O_{2(aq)} \rightarrow O_{2(g)} + 2H_2O_{(l)}$

14. At a particular temperature, a mixture of nitrogen monoxide and oxygen may be represented by the equation below.

$$NO_{(g)} + \tfrac{1}{2}O_{2(g)} \rightleftharpoons NO_{2(g)}$$

The value of the equilibrium constant can be represented as

A. $\dfrac{[NO_2]}{[NO][O_2]}$.

B. $\dfrac{[NO][O_2]}{[NO_2]}$.

C. $\dfrac{[NO_2]}{[NO][\frac{1}{2}O_2]}$.

D. $\dfrac{[NO_2]^2}{[NO]^2[O_2]}$.

15. The oxidation number for vanadium is highest in which of the following compounds?

A. VO_2

B. VO

C. V_2O_3

D. V_2O_5

16. The electrolysis of molten tin(II) bromide using platinum electrodes yields tin and chlorine. In this process the tin ions

A. gain electrons at the anode to form tin.

B. gain electrons at the cathode to form tin.

C. lose electrons at the anode to form tin.

D. lose electrons at the cathode to form tin.

17. The number of moles of hydroxide ions present in 50 cm^3 of 1 M HCl is

A. 1×10^{-7}.

B. 5×10^{-7}.

C. 5×10^{-14}.

D. 5×10^{-16}.

18. The number of possible isomers for the molecule C_2H_2BrCl is

A. 1.

B. 2.

C. 3.

D. 4.

19. Ethene can be converted to ethanol. This type of reaction is called

A. polymerisation.

B. hydration.

C. esterification.

D. dehydration.

20. Which **one** of the following reagents would be expected to react with chloroethane to give ethylamine?

A. Nitrogen

B. Nitric acid

C. Sodium hydroxide

D. Ammonia

21. The resultant magnitude of two forces acting at right angles to each other is 130 N. The magnitude of one of the forces is 50 N. The magnitude of the other component force is

A. 80 N.

B. 120 N.

C. 160 N.

D. 180 N.

22. An automobile accelerates from rest from a stop sign. If the velocity of the car after 6 seconds is 18 ms^{-1}, and the acceleration is uniform, then the magnitude of the acceleration is

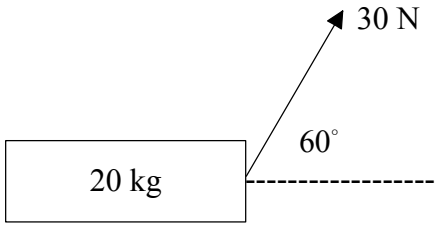
A. 108 ms^{-2}.

B. 12 ms^{-2}.

C. 6 ms^{-2}.

D. 3 ms^{-2}.

23. A force of 30 N is applied to a mass of 20 kg as shown in the following diagram.



The horizontal acceleration experienced by the mass is

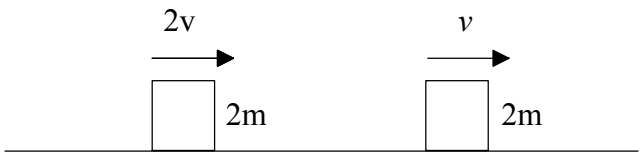
A. 0.75 ms^{-2}.

B. 0.77 ms^{-2}.

C. 1.30 ms^{-2}.

D. 1.33 ms^{-2}.

24. Two identical masses, each of mass 2m, move along a horizontal frictionless surface with velocities of 2v and *v* as shown in the following diagram.



If the two bodies stick together upon collision, the loss in kinetic energy is

A. zero.

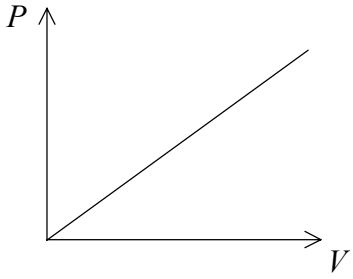
B. $\frac{1}{4}mv^2$.

C. $\frac{1}{2}mv^2$.

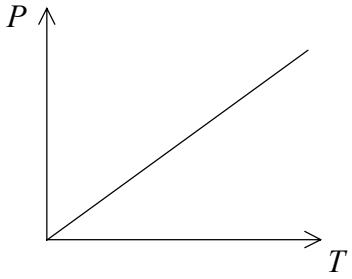
D. $2v^2$.

25. Which of the following graphs is the correct representation of Boyle's Law?

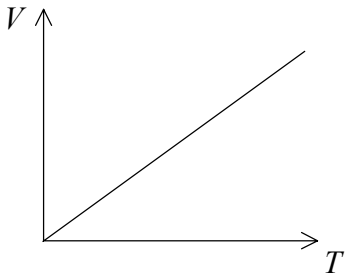
A.



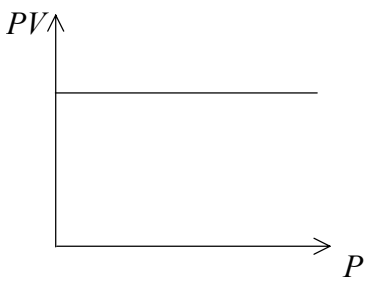
B.



C.



D.



26. A food freezer is placed inside a dark closed insulated room with the power turned on. If the freezer door is left open, the temperature in the room will eventually

A. go below 0 °C.

B. go to 0 °C.

C. decrease.

D. increase.

27. Two conducting spheres of charge Q_1 and Q_2, whose centres are separated by a distance *d,* attract each other with an electrostatic force *F*. If the charge on each sphere is halved and their separation is reduced to one-quarter of its original value, the new force of attraction is given by

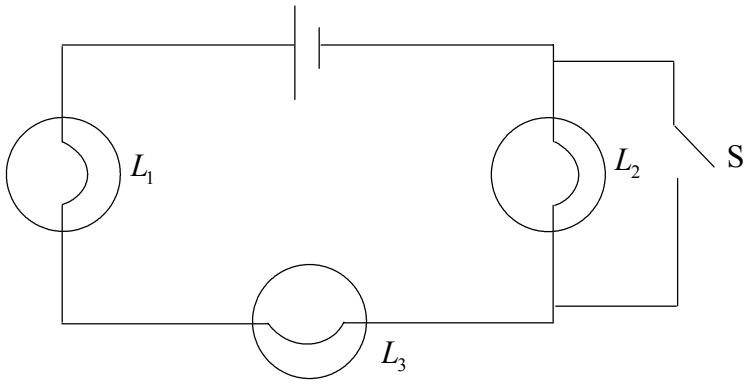
A. *F*.

B. 4 *F*.

C. 8 *F*.

D. 64 *F*.

28. Three identical lamps L_1, L_2 and L_3 are connected as shown in the following diagram.



When switch S is closed

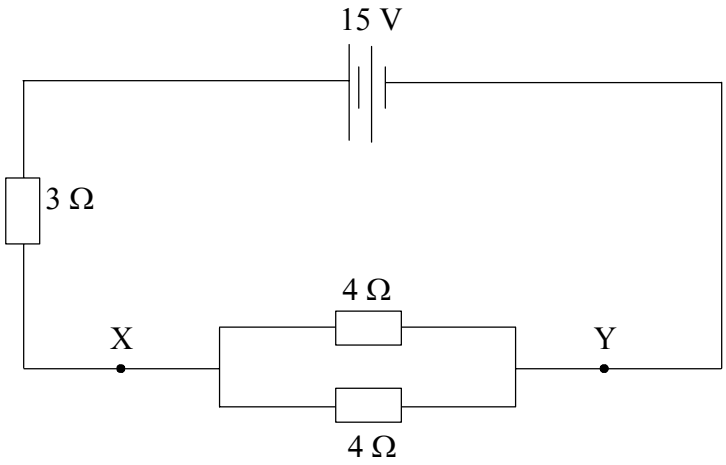
A. L_1 and L_3 brighten and L_2 goes out.

B. all three lamps glow with the same brightness.

C. L_2 brightens and L_1 and L_3 remain unchanged.

D. L_1 and L_3 go dimmer and L_2 goes out.

29. Consider the circuit below that contains a 15 V battery with zero internal resistance.



A voltmeter connected between the points X and Y should read

A. 0 V.

B. 3 V.

C. 6 V.

D. 9 V.

30. Two parallel conducting wires, X and Y, separated by a distance *d* metres carry currents I_1 and I_2, and exert a force per unit length of *F* newton per metre. If the separation between the wires is reduced to $\frac{d}{2}$, the force per unit length is now

A. $\frac{F}{4}$.

B. $\frac{F}{2}$.

C. 2 *F*.

D. 4 *F*.

31. An ideal transformer has a primary coil of 5 000 turns and a secondary coil of 250 turns. The primary voltage produced is 240 V. If a 24 W lamp connected to the secondary coil operates at this power rating, the current in the primary coil is

A. 0.05 A.

B. 0.1 A.

C. 12 A.

D. 20 A.

32. When certain metals are bombarded with high frequency light, photoelectrons are emitted from the metal surface. If the intensity of the light is increased while this high frequency is kept constant,

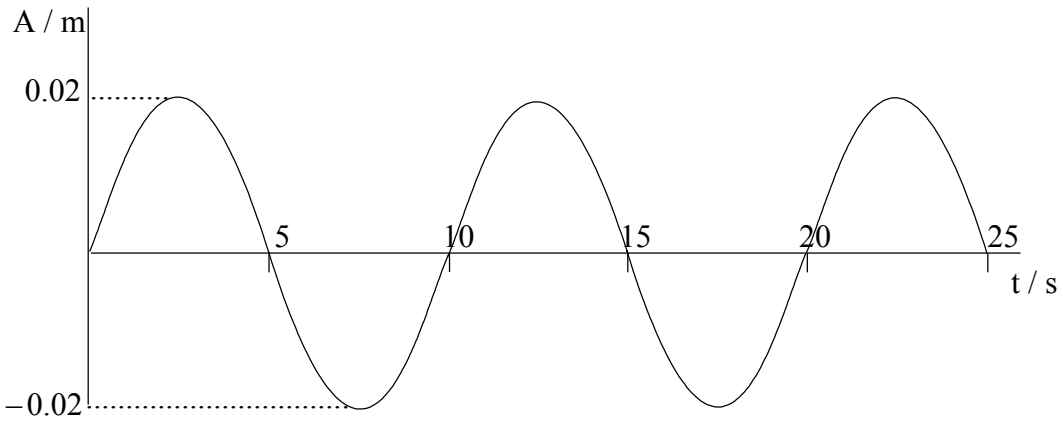
A. more photoelectrons will be emitted with increased speed.

B. more photoelectrons will be emitted with unchanged speed.

C. the same number of photoelectrons will be emitted with increased speed.

D. the same number of photoelectrons will be emitted with unchanged speed.

33. What is the value of the frequency of the wave shown in the sketch below?



A. 0.1 Hz

B. 10 Hz

C. 25 Hz

D. 500 Hz

34. The fact that light can be polarised clearly shows that light is

A. a standing wave.

B. a travelling wave.

C. a transverse wave.

D. a longitudinal wave.

35. A ray of light travels from a type of glass with a refractive index of 1.5 into another glass with a refractive index of 1.3. The critical angle would be

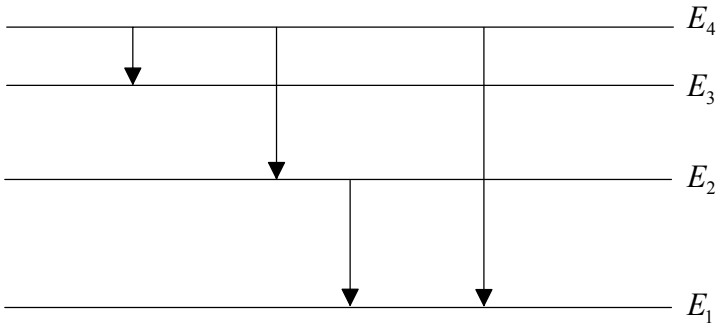
A. 0°.

B. 30°.

C. 60°.

D. 90°.

36. Consider the energy level diagram shown below.



Which of the following transitions is likely to emit radiation with the longest wavelength?

A. $E_4 - E_1$

B. $E_2 - E_1$

C. $E_4 - E_2$

D. $E_4 - E_3$

37. A radioactive substance has a half-life of 2 hours. The fraction of the original material that remains after 6 hours is

A. $\frac{1}{8}$.

B. $\frac{3}{4}$.

C. $\frac{1}{3}$.

D. $\frac{7}{8}$.

38. The de Broglie wavelength of an electron moving with a speed v is equal to λ_0. If the speed is halved the new wavelength would be equal to

A. $\frac{\lambda_0}{2}$.

B. λ_0.

C. $2\lambda_0$.

D. $\sqrt{2\lambda_0}$.

39. When an uranium-235 atom radioactively decays to become a protactinium-231 atom, the radiation emitted consists of

A. one alpha particle.

B. two beta particles.

C. one alpha particle and one beta particle.

D. one beta particle and gamma radiation.

40. A cube of iron with a mass of 49.992 g was placed in $49.5\ \text{cm}^3$ of water in a graduated measuring cylinder. The water level was observed to rise to $55.8\ \text{cm}^3$. From this data, the best value that can be reported for the density of iron is

A. $49.9\ \text{g cm}^{-3}$.

B. $1.266\ \text{g cm}^{-3}$.

C. $7.935\ \text{g cm}^{-3}$.

D. $7.9\ \text{g cm}^{-3}$.