Worcestershire Acute Hospitals NHS Trust

ARTERIAL BLOOD GAS SAMPLING FOR TRAINED PROFESSIONALS

This guidance does not override the individual responsibility of health professionals to make appropriate decision according to the circumstances of the individual patient in consultation with the patient and /or carer. Health care professionals must be prepared to justify any deviation from this guidance.

Introduction

Arterial blood gases are taken to evaluate the patient's:

- Oxygenation
- Ventilation
- Acid base balance

Arterial blood gas samples are usually obtained from a single percutaneous needle puncture into a peripheral artery, although those who require frequent sampling may have an indwelling catheter in situ.

This guideline is for use by the following staff groups :

Qualified Health Professionals (including Doctors, Nurses, Physiotherapists and Respiratory Physiologists) for whom the procedure is within their legal and routine scope of practice in their role, and who have demonstrated proficiency after formal training.

Lead Clinician(s)

Nancy Howard Jane Newport	Respiratory Nurse Specialist/ILD CNS
Approved by Respiratory Directorate on:	29th November 2022
Approved by Specialty Medicine DMB on:	17th January 2023
Review Date: This is the most current document and should be used until a revised version is in place	17th January 2026

Key amendments to this guideline

Date	Amendment	Approved by:
25/10/2022	Guideline checked against latest references. No substantive changes needed	Specialty Medicine DMB

ARTERIAL BLOOD GAS SAMPLING FOR TRAINED HEALTH PROFESSIONALS

INTRODUCTION

Arterial blood gas samples are usually obtained from a single percutaneous needle puncture into a peripheral artery. Arterial blood gases are taken to evaluate the patient's:

- Oxygenation
- Ventilation
- Acid base balance

Key measurements in Arterial Blood Gas Analysis

Measured parameters

- Hydrogen ion concentration (pH)
- Oxygen tension ($P_a O_2$)
- Carbon dioxide tension ($P_a CO_2$)

Calculated parameters

- Bicarbonate concentration(HCO3-)
- Base excess (BE)
- Oxygen concentration (SaO2)

Normal arterial blood gas values	
P_aO_2	10.6 -14.6 kPa*
P_aCO_2	4.5 - 6.0 kPa*
pH	7.35-7.45*
HCO_3	24-30 mmol/L
SaO_2	94% - 98% (dependent on age)*
Base Excess	-2 to +2

*BTS (2017)

Sites for Arterial Puncture

The radial artery is the usual site for arterial blood sampling because it is near to the surface, is easy to palpate and stabilise and there is usually a good collateral supply from the ulnar artery (Williams 1998). The collateral blood supply is assessed by doing an "Allen's test" (page 9). For the purpose of this guideline the radial artery of the non-dominant hand is the artery of choice when performing arterial blood sampling.

If the radial artery cannot be used for arterial blood sampling, other sampling sites are the femoral, brachial or axillary arteries. However, these sites have some disadvantages including poor collateral circulation and structures that could be damaged by a poor technique, (WHO, 2010). These alternatives should only be accessed by personnel who are specifically trained for these sites, and where the radial artery cannot be used.

Complications of arterial puncture

Immediate	Pain, venous sampling, bleeding, haematoma, arteriospasm, nerve damage, inaccurate results due to poor sampling technique leading to inappropriate clinical management
Late	Ischaemia, infection

Girling & Hobbs (1997), WHO (2010)

Competencies required/criteria for competence

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1) Staff doing arterial blood gas sampling must be able to demonstrate that acquisition of this skill is essential for their role.
2) Staff must be able to discuss the key blood gas parameters and know how to act on the results
3) Staff must have completed competency assessment to demonstrate proficiency in the skill.
4) Staff must have their skill recorded on either the Trust or Departmental record.
5) Staff must have their own Point of Care (POC) password for the blood gas analyser, so that there is an accountability record for the sample

Ensuring safe practice

It is expected that medical staff will have had training and competency assessment as part of their basic medical training.

All other health care professionals acting under this policy must have attended a course, which includes arterial blood gas sampling as part of the formal content, and must have completed 10 successful supervised attempts, of which the last 5 should be sequential before they can act independently.

Staff should expect to perform ABG samples monthly as a normal part of their role, in order to maintain their level of competence. In accordance with their professional duty of care, staff should seek retraining if they have a period where the skill is not being used and competency is lost.

Due to the limited number of blood gas sampling sites, staff (including doctors) are allowed a maximum of two attempts at obtaining a blood gas sample from a patient. After two failed attempts, another practitioner must take over.

Arterial sampling must not be performed on limbs with evidence of:

- Peripheral vascular disease
- Infection
- Skeletal trauma
- Surgical shunt
- Raynaud's or Berger's disease

(Coombs 2001)

Patients Covered

There are a number of circumstances where a patient will require blood gas analysis:

- Assessment of supplementary oxygen requirements
- Prior to and during Non-Invasive Positive Pressure Ventilation
- Post cardiac arrest
- Diabetic ketoacidosis
- Poisoning
- Shock from any cause
- Acute renal failure

Blood gas sampling should also be considered in the following clinical situations:

- Any unexpected deterioration in an ill patient
- Anyone with an acute exacerbation of a chronic chest condition
- Anyone with impaired consciousness
- Anyone with impaired respiratory effort

Critically ill patients and those with shock or a systolic blood pressure < 90 mm/Hg should have their initial blood gas sample obtained from an artery, (BTS 2017).

In some circumstances blood gas analysis may be done via other techniques. For example, in diabetes or renal failure, where pH values need to be assessed, venous blood sampling may be appropriate. Capillary Blood Gas (CBG) sampling can provide accurate readings for pH and pCO2, but not pO2. However, "The technique of patient preparation, sample acquisition and sample processing for arterialised capillary gases is complex and should only be undertaken by fully trained staff." (BTS, 2017) If there is any doubt about the result, an ABG should be done.

As the person who obtains the sample is also the person who processes the sample, they have immediate access to the results. Staff must recognise that their responsibility for the sample does not end once the result is available. They must act on the results. Escalating the result to a doctor or senior is an appropriate action. Filing the blood gas result for review later is not.

GUIDELINE

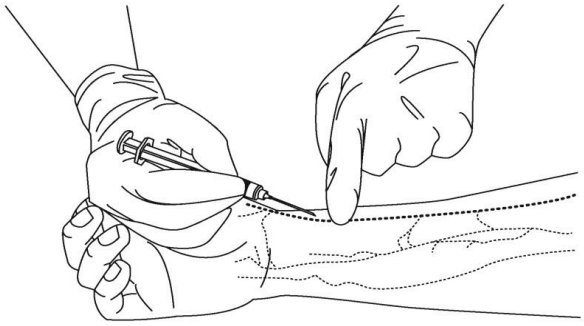
Equipment

- Heparinised blood gas syringe and safety needle
- Trust approved skin cleaning wipe
- Gauze swab
- Tape
- Sharps box
- Patient label
- Gloves

This procedure requires two people: one to perform the procedure and analyse the sample and a second to maintain pressure on the puncture site following the procedure. It is unreasonable to expect an ill patient to take responsibility for achieving haemostasis post procedure.

Procedure

Action	Rationale
Gather the equipment you need	Efficient use of time
Check that you have the correct patient	Patient safety
Explain the procedure to the patient	To obtain informed consent and co-operation
Wash hands and put on protective gloves and an apron	To reduce the risk of infection
Position the patient in the semi-recumbent position	To decrease the risk of vasovagal response
Palpate the radial pulses in both wrists, starting with their non-dominant hand	To identify the most appropriate site
When the site is identified perform a modified “Allen’s Test” (see below)	To assess the collateral arterial blood supply to the hand through the ulnar artery.
For radial puncture, the patient’s wrist is gently extended and supinated. This should not be uncomfortable for the patient. Supporting the patient’s wrist may help (e.g. with rolled up towel or pillowcase)	To expose puncture site and facilitate arterial puncture

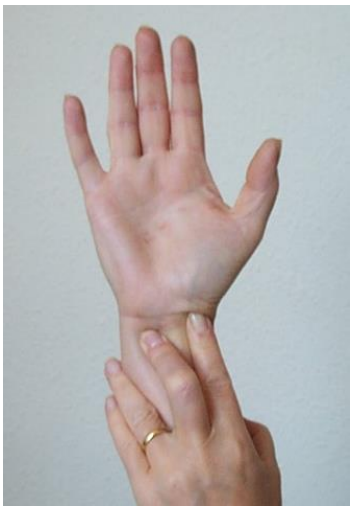
Confirm the location of the artery by palpation and clean the sample site with a Trust approved skin cleaning swab. Allow to air dry	To reduce the risk of infection
Ensure the blood gas syringe is assembled, with the safety needle in situ	Correct equipment required
If using a syringe with liquid heparin, expel excess heparin and any air bubbles by holding the syringe vertically and the needle uppermost	To fill the dead space within the needle and syringe and to coat the syringe with heparin.
If using a syringe with dry heparin, move the plunger to ensure it slides smoothly, and follow the instructions on the pack (some syringes require the plunger to be pushed up to the top of the syringe and the plunger will spontaneously move back as the blood fills the syringe. Some require you to pull the plunger back to the fill quantity you require (approx. 0.5 ml)	To ensure correct sampling technique
The artery is then fixed using the index finger of the non-dominant hand, and the needle, bevel up, is introduced through the skin at an angle of 30-45°. The needle is then passed through the wall of the artery (warn the patient that this may be uncomfortable). On entering the artery, the syringe will fill spontaneously. Withdraw approximately 0.5 ml of blood. (Sample size required is 150 microliters) If no blood obtained, withdraw needle slowly, observing for pulsation at the base of the needle.	Picture copyright WHO (2010)  Locate artery and take a sample

Withdraw the needle and immediately apply firm pressure with a gauze swab for a minimum of 5 minutes or longer if site bleeds (10 minutes if anticoagulated)	To decrease the risk of bruising and bleeding. Bruising at the site is a sign of poor practice and additionally, will hinder repeat sample collection
Expel any air bubbles from the syringe, dispose of the needle into the sharps box and cap the syringe. Attach the addressograph label.	If the syringe is prepared properly and the sample taken correctly, there will be no air bubbles present. Air bubbles will allow gases to diffuse between the air bubble and the blood sample leading to a decrease in PaCO2 and an increase in PaO2 (Williams 1998) To ensure proper identification of sample
Remove gloves and wash hands	To reduce the risk of infection
Note the patient's inspired oxygen concentration (FiO_2) – usually expressed as a percentage (e.g. 24%) and temperature	To ensure that results can be interpreted correctly
The sample should be analysed immediately according to the protocol from the Biochemistry department.	The cellular constituents of blood remain metabolically active so gas tensions in the sample will change with time. If the sample cannot be analysed within 15 minutes it should be cooled to 5°C by placing sample on crushed ice–it can then be stored for up to one hour without any clinically significant effect on the result (Williams 1998)
The person taking the sample must use their personal blood gas analyser login details to access the machine	To conform to the Trust's "Point of Care Testing" Policy (WHAT-PAT-001)
Details of the procedure including informed consent, site and number of attempts made should be recorded and signed for in the patient record. The main ABG results should be recorded in the patient's notes • Ph • PaCO2 • PaO2 • HCO3- • Base Excess	To maintain effective communication The results from the sample print out can fade, especially if exposed to water, alcohol or sellotape.

Any other abnormal results on the sample must also be recorded and escalated	The blood gas analysers provide a range of different results (depending on the department), which may include Hb, lactate, potassium and glucose.
The sampling process is not compete until any abnormalities have been identified and acted upon, or escalated to someone who can.	Maintain patient safety
The blood gas result must be attached to a “Blood Gas Results Sheet”.(WR5407). This form should be completed, including documentation of the FiO2, NIV or CPAP setting (if appropriate) and the plan of action,	To ensure that the accountability record is complete and the result is available for future reference.

Modified Allen's Test

This test is performed to check the adequacy of the ulnar artery as collateral blood supply to the hand. Hold the patient's hand above the level of their heart and apply enough pressure with your fingers to both the radial and ulnar arteries to occlude them.


Ask the patient to make a clenched fist and relax it several times. After one minute of occlusion, ask the patient to unclench the hand and lower it. The whole hand should appear pale. The hand is opened and the pressure on the ulnar artery is released while maintaining pressure on the radial artery. Measure the elapsed time until the hand returns to normal colour. More than 6 seconds is classified as delayed. If the test shows delay on only one hand, perform the arterial puncture on the other. If both hands show delay, the arterial puncture may have to be performed on an alternative site (Tape T 1996).

MONITORING TOOL

Competency will be reviewed annually as part of staff appraisal and adherence to the guideline is the remit of the ward/department manager.

Monitoring

Page/ Section of Key Document	Key control:	Checks to be carried out to confirm compliance with the Policy:	How often the check will be carried out:	Responsible for carrying out the check:	Results of check reported to: *(Responsible for also ensuring actions are developed to address any areas of non-compliance)*	Frequency of reporting:
	WHAT?	**HOW?**	**WHEN?**	**WHO?**	**WHERE?**	**WHEN?**
	These are the 'key' parts of the process that we are relying on to manage risk. We may not be able to monitor every part of the process, but we MUST monitor the key elements, otherwise we won't know whether we are keeping patients, visitors and/or staff safe.	What are we going to do to make sure the key parts of the process we have identified are being followed? (Some techniques to consider are; audits, spot-checks, analysis of incident trends, monitoring of attendance at training.)	Be realistic. Set achievable frequencies. Use terms such as '10 times a year' instead of 'monthly'.	Who is responsible for the check? Is it listed in the 'duties' section of the Policy? Is it in the job description?	Who will receive the monitoring results? Where this is a committee the committee's specific responsibility for monitoring the process must be described within its terms of reference.	Use terms such as '10 times a year' instead of 'monthly'.
Page 3	There is documented evidence that the staff member taking the arterial sample has been trained in the technique	Spot checks. Each ward manager should hold a record of staff who are competent to take ABG's	Twice yearly	Ward Managers/ Department manager	Report will be sent to the relevant directorate managers	Twice yearly
Page 3	The person who took the sample used their personal blood gas analyser login	Spot checks	3 sample per 3 months at each site (WRH, KTC, ALEX)		Report will be sent to the relevant directorate managers	4 times per year

References

- BTS guideline for oxygen use in adults in healthcare and emergency settings (2017) B R O'Driscoll, L S Howard, J Earis, V Mak, on behalf of the British Thoracic Society Emergency Oxygen Guideline Group **Thorax** Vol 72 Supplement 1 pp i1 – i90
- Coombs M (1997) Making sense of arterial blood gases **Nursing Times** Vol 97, No 27 p36-38.
- Girling K Hobbs G (1997) Arterial blood sampling and peripheral arterial cannulation in **Essential Medical Procedures** (Peter J Toghill Ed) Arnold London.
- Tape G (1996) Arterial puncture for blood gas analysis in **Procedural Skills for Internal Medicine (**Wigton R S, Tape T eds) Mosby, St Louis
- WHO Guidelines on Drawing Blood: **Best Practices in Phlebotomy**. Geneva: World Health Organization; 2010. 5, Arterial blood sampling. Available from: https://www.ncbi.nlm.nih.gov/books/NBK138661/
- Williams A J (1998) Assessing and interpreting arterial blood gases and acid-base balance **British Medical Journal** Vol 317 p1213-1216

Contribution List

Contribution List

This key document has been circulated to the following individuals for consultation;

Designation
Sarah Austin - Respiratory Specialist Nurse
All Respiratory Consultants
All Respiratory Nurse Specialist
Jane Newport
All ILD Nurse Specialists
Dr Ed Mitchell (for anaesthetics)
Dr Jules Walton (for ED)
Sarah Troth (for AHCP's)

This key document has been circulated to the chair(s) of the following committee's / groups for comments;

Committee

Supporting Document 1 - Equality Impact Assessment Tool

To be completed by the key document author and included as an appendix to key document when submitted to the appropriate committee for consideration and approval.

Please complete assessment form on next page;

NHS Worcestershire Acute Hospitals NHS Trust

NHS Worcestershire Acute Hospitals NHS Trust

Herefordshire & Worcestershire STP - Equality Impact Assessment (EIA) Form

Please read EIA guidelines when completing this form

Section 1 - Name of Organisation (please tick)

Herefordshire & Worcestershire STP		Herefordshire Council		Herefordshire CCG	
Worcestershire Acute Hospitals NHS Trust	X	Worcestershire County Council		Worcestershire CCGs	
Worcestershire Health and Care NHS Trust		Wye Valley NHS Trust		Other (please state)	

Name of Lead for Activity	

Details of individuals completing this assessment	**Name**	**Job title**	**e-mail contact**
	Jane Newport	**Lead Practitioner Respiratory**	**j.newport@nhs.net**
Date assessment completed			

Section 2

Activity being assessed (e.g. policy/procedure, document, service redesign, policy, strategy etc.)	**Arterial Blood Gas Sampling for Trained Health Professionals** Update of guideline for clinical practice				
What is the aim, purpose and/or intended outcomes of this Activity?	To ensure that patient safety is maintained and that the sample obtained is accurate, analysed correctly and actioned appropriately				
Who will be affected by the development & implementation of this activity?	❑ ☑ ❑ ❑	Service User Patient Carers Visitors	☑ ❑ ❑ ❑	Staff Communities Other _____	
Is this:	☑ Review of an existing activity ❑ New activity ❑ Planning to withdraw or reduce a service, activity or presence?				
What information and evidence have you reviewed to help inform this assessment? (Please name sources, eg demographic information for patients / services / staff groups affected, complaints etc.	BTS guideline for oxygen use in adults in healthcare and emergency settings (2017) B R O'Driscoll, L S Howard, J Earis, V Mak, on behalf of the British Thoracic Society Emergency Oxygen Guideline Group **Thorax** Vol 72 Supplement 1 pp i1 – i90 WHO Guidelines on Drawing Blood: **Best Practices in Phlebotomy**. Geneva: World Health Organization; 2010. 5, Arterial blood sampling. Available from: https://www.ncbi.nlm.nih.gov/books/NBK138661/				
Summary of engagement or consultation undertaken (e.g. who and how have you engaged with, or why do you believe this is not required)	All respiratory consultants and hospital based respiratory nurses Representatives from ED, anaesthetics and the AHP's				
Summary of relevant findings	Correction of wording and grammar only. No clinical concerns raised about the recommended practice				

Section 3

Please consider the potential impact of this activity (during development & implementation) on each of the equality groups outlined below. **Please tick one or more impact box below for each Equality Group and explain your rationale**. Please note it is possible for the potential impact to be both positive and negative within the same equality group and this should be recorded. Remember to consider the impact on e.g. staff, public, patients, carers etc. in these equality groups.

Equality Group	Potential positive impact	Potential neutral impact	Potential negative impact	Please explain your reasons for any potential positive, neutral or negative impact identified
Age		X		This policy is to ensure that staff are competent in the skill and use the best technique when taking an arterial sample. This impact will be equal across the board, regardless of the individual's equality group, for both the person taking the sample and the patient being tested.
Disability		X		
Gender Reassignment		X		
Marriage & Civil Partnerships		X		
Pregnancy & Maternity		X		
Race including Traveling Communities		X		
Religion & Belief		X		
Sex		X		
Sexual Orientation		X		
Other Vulnerable and Disadvantaged Groups (e.g. carers; care leavers; homeless; Social/Economic deprivation, travelling communities etc.)		X		
Health Inequalities (any preventable, unfair & unjust differences in health status between groups, populations or individuals that arise from the unequal		X		This policy is to ensure that staff are competent in the skill and use the best technique when taking an arterial sample. This impact will be equal across the

Equality Group	Potential positive impact	Potential neutral impact	Potential negative impact	Please explain your reasons for any potential positive, neutral or negative impact identified
distribution of social, environmental & economic conditions within societies)				board, regardless of the individual's equality group, for both the person taking the sample and the patient being tested.

Section 4

What actions will you take to mitigate any potential negative impacts?	Risk identified	Actions required to reduce / eliminate negative impact	Who will lead on the action?	Timeframe
	None	.		
How will you monitor these actions?	Nil required. This guideline is appropriate for all groups, from both staff and patient perspectives.			
When will you review this EIA? (e.g in a service redesign, this EIA should be revisited regularly throughout the design & implementation)	At next guideline up-date			

Section 5 - Please read and agree to the following Equality Statement

1. Equality Statement

1.1. All public bodies have a statutory duty under the Equality Act 2010 to set out arrangements to assess and consult on how their policies and functions impact on the 9 protected characteristics: Age; Disability; Gender Reassignment; Marriage & Civil Partnership; Pregnancy & Maternity; Race; Religion & Belief; Sex; Sexual Orientation

1.2. Our Organisations will challenge discrimination, promote equality, respect human rights, and aims to design and implement services, policies and measures that meet the diverse needs of our service, and population, ensuring that none are placed at a disadvantage over others.

1.3. All staff are expected to deliver services and provide services and care in a manner which respects the individuality of service users, patients, carer's etc, and as such treat them and members of the workforce respectfully, paying due regard to the 9 protected characteristics.

Signature of person completing EIA	Jane Newport
Date signed	15/12/2022
Comments:	
Signature of person the Leader Person for this activity	
Date signed	
Comments:	

Worcestershire Acute Hospitals NHS Trust

Supporting Document 2 – Financial Impact Assessment

To be completed by the key document author and attached to key document when submitted to the appropriate committee for consideration and approval.

	Title of document:	Yes/No
1.	Does the implementation of this document require any additional Capital resources	No
2.	Does the implementation of this document require additional revenue	No
3.	Does the implementation of this document require additional manpower	No
4.	Does the implementation of this document release any manpower costs through a change in practice	No
5.	Are there additional staff training costs associated with implementing this document which cannot be delivered through current training programmes or allocated training times for staff	No
	Other comments:	

If the response to any of the above is yes, please complete a business case and which is signed by your Finance Manager and Directorate Manager for consideration by the Accountable Director before progressing to the relevant committee for approval.

Worcestershire Acute Hospitals NHS Trust

Appendix 1: Competency Sheet

ASSESSMENT OF COMPETENCY FOR ARTERIAL BLOOD GAS SAMPLING

ASSESSMENT SPECIFICATION: The candidate should be able to demonstrate competence in arterial blood gas sampling using the following knowledge evidence and performance criteria

KNOWLEDGE EVIDENCE: The candidate should be able to:

a) Demonstrate skill in the technique of arterial blood gas sampling
b) Discuss the principles of safe practice with regards to arterial blood gas sampling
c) Discuss the role, responsibility and accountability with reference to the Code of Professional Conduct.
d) Know the normal ranges for arterial blood gas values
e) Demonstrate a systematic approach to arterial blood gas interpretation
f) Explore the common causes of arterial blood gas abnormalities and discuss management interventions.

You need a mentor who is competent in arterial blood gas sampling who has a completed a recognised arterial blood gas sampling training and ENB 997/998 or C & G 730 or similar

If the candidate still feels they lack competence after supervised practice of at least 10 arterial blood gas samplings, they should seek further training or supervised practice.

- Please attempt to complete competencies within 6-8 weeks of attending course
- Any problems, please contact Professional Development (01905) 760825 Ext 33743

Clinical Supervisor *(please print):* …… Signature: …… Date:……..

Candidate *(please print)*: …… Signature: …… Date: ……

Ward/Department: …….. Directorate/ PCT: …… Location: ……..

Comments by Supervisor	**Comments by Candidate:**

When you have completed your competencies, please send a PHOTOCOPY of this form to:
Professional Development Administrator, Charles Hastings Education Centre, WRH

Worcestershire Acute Hospitals NHS Trust

Worcestershire Acute Hospitals NHS Trust

PERFORMANCE CRITERIA FOR ASSESSMENT OF COMPETENCY FOR ARTERIAL BLOOD GAS SAMPLING

PERFORMANCE CRITERIA	COMPETENT- Mentor Initial & Date									
	1	2	3	4	5	6	7	8	9	10
Identifies need for arterial blood gas sampling according to Trust Policy										
Explains procedure to patient and obtains consent.										
Prepares the necessary equipment.										
Identifies the appropriate site.										
Performs modified Allen's Test.										
Confirms location of artery and cleans site and with chloroprep										
Stabilises artery, demonstrates correct angle of entry and obtains arterial sample.										
Prepares sample for analysis.										
Notes patients inspired 02 concentration (FI02) and temperature.										
Analyses sample according to biochemistry protocol.										
Records the procedure in patients notes Procedure and site No of attempts Main ABG results ph, PaCO2, PaO2, HCO3, Base Excess										
Acts on results according to Trust Policy.										
Informs medical staff of results.										

I declare that I have supervised this practitioner and found him/her to competent as judged by these knowledge and performance criteria

Clinical Supervisor (*please print): ……* **Signature**: ……**Date:** ….....

I declare that I have expanded my knowledge and skills and undertake to practice with accountability for my decisions and actions

Candidate *(please print)*: ……**Signature:** …… **Date:** ……