Instructions:

1. Complete the following questions.
2. Show complete work to the best of your knowledge. Try not to leave anything blank.
3. Respect significant figures where appropriate.

Questions:

1. Give the balanced chemical equation for the following chemical reaction:

   Dinitrogen monoxide gas breaks down into nitrogen gas and oxygen gas.

$$2N_2O_{(g)} \rightarrow 2N_{2\,(g)} + O_{2\,(g)}$$

2. If 10.0 mL of a 0.30 mol/L sodium phosphate (Na_3PO_4) solution reacts with 20.0 mL of a 0.20 mol/L lead(II) nitrate ($Pb(NO_3)_2$) solution, what is the mass of the precipitate?

$$3\,Pb(NO_3)_2\,(aq) + 2\,Na_3PO_4\,(aq) \rightarrow Pb_3(PO_4)_2\,(s) + 6\,NaNO_3\,(aq)$$

NOTE:

(1) Your work does not have to be exactly like what is shown below. However, it does have to clearly show your logic. It should also include properly labelled units throughout the problem.
(2) This answer key also includes descriptive titles for each section. Your work doesn't need to.

Number of moles of each reactant:

$$10.0\,mL\ Na_3PO_4\left(\frac{1\,L}{1000\,mL}\right)\left(\frac{0.30\,mol\ Na_3PO_4}{1\,L}\right) = 0.0030\,mol\ Na_3PO_4$$

$$20.0\,mL\left(\frac{1\,L}{1000\,mL}\right)\left(\frac{0.20\,mol\ Pb(NO_3)_2}{1\,L}\right) = 0.0040\,mol\ Pb(NO_3)_2$$

Determine the limiting reagent by seeing how much product can be produced:

IF Na_3PO_4 is limiting:

$$0.0030\,mol\ Na_3PO_4\left(\frac{1\,mol\ Pb_3(PO_4)_2}{2\,mol\ Na_3PO_4}\right) = 0.0015\,mol\ Pb_3(PO_4)_2$$

IF $Pb(NO_3)_2$ is limiting:

$$0.0040\,mol\ Pb(NO_3)_2\left(\frac{1\,mol\ Pb_3(PO_4)_2}{3\,mol\ Pb(NO_3)_2}\right) = 0.0013333\,mol\ Pb_3(PO_4)_2\ (should\ be\ 2\ s.f.)$$

Since lead (II) nitrate leads to less product, it is the limiting reagent.

Use the limiting reagent to determine mass of the precipitate:

$$0.0013333\,mol\ Pb_3(PO_4)_2\left(\frac{811.54\,g\ Pb_3(PO_4)_2}{1\,mol\ Pb_3(PO_4)_2}\right) = 1.082026\,g\ Pb_3(PO_4)_2$$

$$\mathbf{1.1\,g\ Pb_3(PO_4)_2\ (with\ sig.figs.)}$$

Alternatively, you could use an IRF table to help determine more information at the same time.

	$2Na_3PO_4$	+	$3Pb(NO_3)_2$	→	$Pb_3(PO_4)_2$	+	$6NaNO_3$
Initial (mol)	0.0030		0.0040		0		0
Reaction (mol)	-2x		-3x		+x		+6x
Final (mol)	0.0030-2x		0.0040-3x		x		6x

To solve for reaction value, the limiting reagent must be completely consumed.

$$0.0040 - 3x = 0$$

$$x = 0.0013333$$

Therefore, the IRF table can be completed (values displayed to correct sig. figs.; however unrounded values will be used in future calculations):

	$2Na_3PO_4$	+	$3Pb(NO_3)_2$	→	$Pb_3(PO_4)_2$	+	$6NaNO_3$
I (mol)	0.0030		0.0040		0		0
R (mol)	-2x		-3x		+x		+6x
F (mol)	0.0017		0		0.0013		0.0080

To determine mass of the precipitate:

$$0.0013333\ mol\ Pb_3(PO_4)_2 \left(\frac{811.54\ g\ Pb_3(PO_4)_2}{1\ mol\ Pb_3(PO_4)_2}\right) = 1.082026\ g\ Pb_3(PO_4)_2$$

$$\mathbf{1.1\ g\ Pb_3(PO_4)_2\ (with\ sig.figs.)}$$