Assessment Guide

Domain	Mathematics and Mechanics eLearning course (NCME Year 1, Night/Correspondence)

Unit	21908 v3	Demonstrate knowledge of basic mechanics for mechanical engineering trades	Level 2	Credits 3

Candidate details	
Name	**Company**
NSI No.	**Email / Phone**

Assessor details	
Name	**Company**
Verifier details (if required)	
Name and Company	**Email / Phone**

Pre-requisite confirmation

I, the Assessor, can confirm that the candidate holds the pre-requisite(s) for this unit standard.

- ☐ Yes
- ☐ No
- ☐ Not applicable

Assessment result

Assessor judgement:	☐ Achieved ☐ Not yet achieved	**Assessor stamp**
Signature	**Date**	

Candidate response

I, the Candidate:

☐ Agree with the assessment result. ☐ Wish to appeal the assessment result

Signature	**Date**

Assessment Guide

Change control

The following changes have been made to 21908 v3 assessment materials.

Edition of this document	Changes made
Edition 5 Nov 2018	• Corrected question 14 wording to “unbalance” and “beam”, and illustration to match wording. • Updated to current format.
Edition 4	• Corrected model answer, question 5 in Shapes and Angles 1: Area (Module 4) Answer should be in mm and not mm^2.
Edition 3	• Basic Maths: question 4 reworded.
Edition 2 Jan 2014 Sept 2013	• Updated Assessor instructions on page 7 to reflect new system feature for assessment short answer questions. Primarily the student only has to re-answer the questions they get incorrect. • Updated images in Model Answers to reflect images in online assessment. • Ensured the value of Pi throughout assessment is referred to as 3.14 • Basic Maths: question 3 updated formula pop-up information and updated last answer option • Quantities & Units of Measurement: question 5 added to definition of ‘Pressure’; Case study starting at question 6 updated positional accuracy to 0.001 inches; question 17 updated accuracy to +/- 0.2 5mm and inches to 0.001”; question 18 updated answer options • Shapes and Angles 1 (Area): question 7 updated image to show 13mm, and updated model answer; in Well Done section updated total area of object to read 3325.6mm^2 • Shapes and Angles 2 (Volume): updated to reflect Pi value of 3.14 – this affected model answers to questions 2, 3, 4 + 6; question 6 length of cylinder is 304.8 mm; Well Done section updated total volume of object to read 397628.21 mm^3 • Simple Machines: removed original questions 11 and 12 about the tank filled with water (did not replace, however these questions and model answers are in the Appendix of this document for your reference); updated question numbers to reflect this change; question 11 (was 13) updated Gravity unit of measure in popup to read m/s^2; question 14 (was 16) updated instruction to round answer to two decimal points; question 16 (was 18) updated image + added in new image for assessor in Model Answers; question 17 (was 19) added in new image for assessor in Model Answers.
Edition 1 Jan 2013	No changes. Original document.

Assessment Requirements

This Assessment Guide is designed to help you provide evidence of your skills and knowledge required by this unit standard.

Before you begin

Read through the assessment requirements yourself. Talk with your assessor or training advisor if there is anything you don't understand.

Meet with your assessor to plan your assessment. Your assessor will:

» Talk you through this Guide, and discuss when and how you will be assessed.

» Check you are ready to begin this assessment.

What you need to do

1. Complete the following assessment tasks:

Questions	Answer questions about basic mechanics for mechanical engineering trades. This includes: » Simple machines. » Friction in an engineering environment. » Pascal's Law.

2. You may wish to provide additional supporting evidence that proves you have the knowledge and skills required by this unit. Additional evidence may include, for example, workplace documentation you have used and/or completed, training records, photos, screenshots, printouts, videos, voice recordings.
3. When you have completed all assessment tasks, complete the 'Candidate evidence check' at the end of this Guide.
4. When you are sure you have completed and/or attached everything, contact your assessor or Training Advisor to arrange next steps.

Conditions

» Your evidence must clearly show you are able to demonstrate knowledge of simple machines, friction in an engineering environment, and Pascal's Law.

» Complete all assessment tasks yourself.

  » Answer questions yourself, using your own words.

  » Any evidence you attach must be your own work. This includes any work samples, photos and/or completed documents.

» Formulae shall be supplied.

» Use of a calculator is permitted.

References

The assessment tasks must be completed in accordance with the following:

» *The International System of Units (SI), 8th edition* (France: Bureau International des Poids et Mesures, 2006). Available at http://www.bipm.org/utils/common/pdf/si_brochure_8_en.pdf

Questions

Answer the following questions about basic mechanics for mechanical engineering trades.

Use your own words. You can answer the questions in writing, or give your answers verbally to your assessor who will write down what you say. You may need to arrange this in advance.

Your assessor may ask you additional questions to check your knowledge and understanding.

Use a calculator is permitted. You may also use graph paper, ruler and protractor to help work out the answers for the angle and scaling questions.

Your name	
Workplace	

Simple Machines ☑

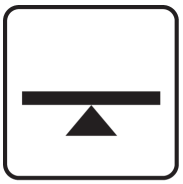
1. Match the simple machine to the description of how it works. Enter the number of the machine against the correct description. ☐

Simple Machine		Description	Answer
 INCLINED PLANE	**1**	A grooved wheel with a rope or cable around it	
 LEVER	**2**	A slanting surface connecting a lower level to a higher level	
 WEDGE	**3**	An inclined plane wrapped around a cylindrical rod	
 SCREW	**4**	An object with at least one slanting side ending in a sharp edge	
 WHEEL & AXLE	**5**	A stiff bar that rests on a support called a fulcrum	
 PULLEY	**6**	A wheel with a rod called an axle through its centre	

Simple Machines ☑

2. Which of the following is a type of lever? ☐

Select the **two** best answers.



LEVER

- ☐ Bolt
- ☐ Bike
- ☐ Lift
- ☐ Spade
- ☐ Chisel
- ☐ Crowbar
- ☐ Vice
- ☐ Doorknob
- ☐ Crane
- ☐ Door stop

3. Which of the following is a type of wedge? ☐

Select the **two** best answers.

WEDGE

- ☐ Bolt
- ☐ Bike
- ☐ Lift
- ☐ Spade
- ☐ Chisel
- ☐ Crowbar
- ☐ Vice
- ☐ Doorknob
- ☐ Crane
- ☐ Door stop

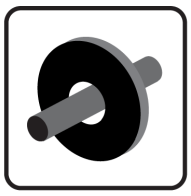
Simple Machines ☑

4. Which of the following is a type of screw?
Select the **two** best answers. ☐


SCREW

- ☐ Bolt
- ☐ Bike
- ☐ Lift
- ☐ Spade
- ☐ Chisel
- ☐ Crowbar
- ☐ Vice
- ☐ Doorknob
- ☐ Crane
- ☐ Door stop

5. Which of the following is a type of wheel and axle?
Select the **two** best answers. ☐


WHEEL & AXLE

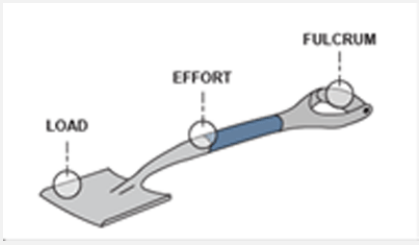
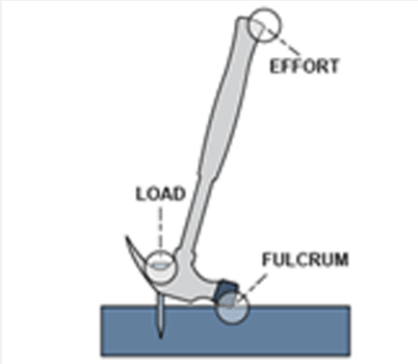
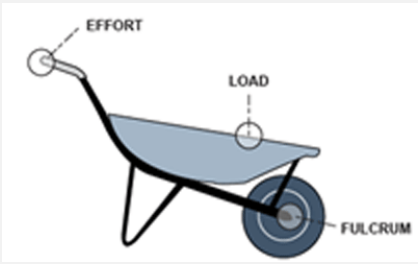
- ☐ Bolt
- ☐ Bike
- ☐ Lift
- ☐ Spade
- ☐ Chisel
- ☐ Crowbar
- ☐ Vice
- ☐ Doorknob
- ☐ Crane
- ☐ Door stop

Simple Machines	☑
6. Which of the following is a type of pulley? Select the **two** best answers.	☐

- ☐ Bolt
- ☐ Bike
- ☐ Lift
- ☐ Spade
- ☐ Chisel
- ☐ Crowbar
- ☐ Vice
- ☐ Doorknob
- ☐ Crane
- ☐ Door stop

Simple Machines ☑

7. Match the class of lever with the example that it belongs to. Enter the number of the example against the correct class of lever. ☐

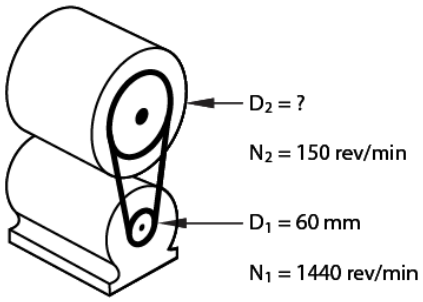
Example		Class	Answer
	**1**	First Order	
	**2**	Second Order	
	**3**	Third Order	

Simple Machines ☑

8. Transpose the following formula for calculating pulley torque to find D_2. ☐

Formula: $\frac{D_2}{D_1} = \frac{N_1}{N_2}$

Select the correct answer.



This is an electrical motor that drives a rotating drum using two pulleys.

The motor pulley is 60mm in diameter and runs at 1440 rev/min.

The drum must rotate at 150 rev/min.

☐ $\boldsymbol{D_2 = \frac{N_1 \times D_1}{N_2}}$

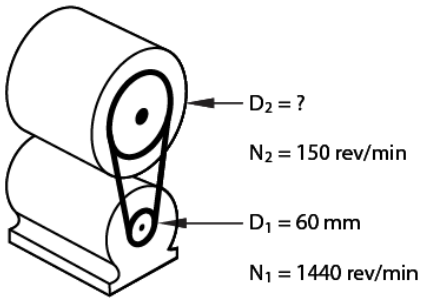
☐ $D_2 = \frac{N_2 \times D_1}{N_1}$

☐ $D_2 = \frac{N_1}{N_2 \times D_1}$

☐ $D_2 = \frac{N_2}{N_1 \times D_1}$

9. Using the formula from the previous answer, calculate D_2 to find the size of pulley that must be fitted. ☐

Formula: $\frac{D_2}{D_1} = \frac{N_1}{N_2}$



This is an electrical motor that drives a rotating drum using two pulleys.

The motor pulley is 60mm in diameter and runs at 1440 rev/min.

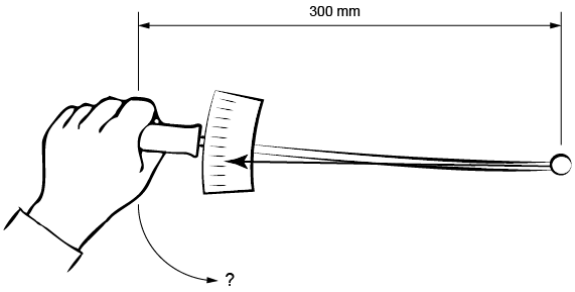
The drum must rotate at 150 rev/min.

Pulley = mm

Simple Machines	☑

10. Calculate the force required on the handle of the torque wrench for the dial to read 45 Nm. ☐

Formula: Torque = force x perpendicular distance

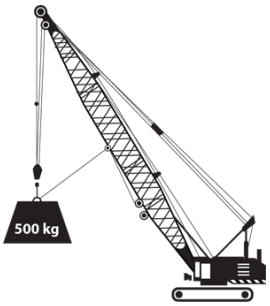


Force = N

11. Calculate the force in Newtons that the crane needs to overcome when lifting the 500 kg load. ☐

Formulae: Force (N) = mass (kg) x acceleration due to gravity (m/s^2)

Gravity: 9.81 m/s^2

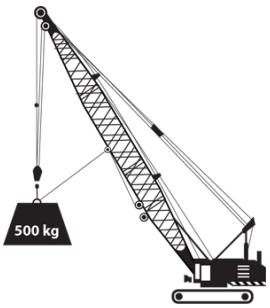


Force = N

Note down your answer as you will need it for the next question

12. Calculate the work done in Joules by the crane when lifting the load 2 metres. ☐

Formula: Work done (J) = force (N) x distance (m)



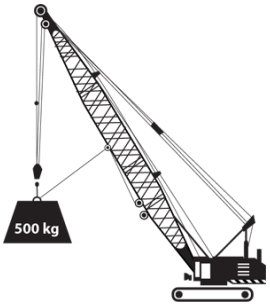
Work done = J

Note down your answer as you will need it for the next question

Simple Machines ☑

13. Calculate the power needed by the crane in Watts (W) to lift the load 2 metres in 15 seconds. ☐

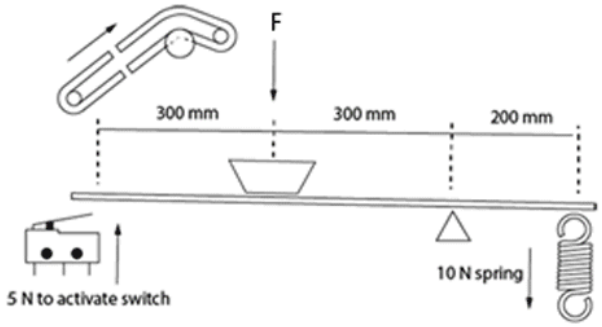
Formula: Power (W) = $\frac{\text{Work done (J)}}{\text{Time (s)}}$



Power = W

14. Read the scenario in the picture below, then calculate the force (F) in Newtons (N) that will just unbalance the beam. Round your answer to two decimal places. ☐

Formula: Clockwise force = Anti-clockwise force



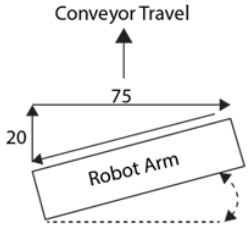
Force = N

A scale consists of a microswitch that will switch off the conveyor when activated by a 5 Newton load. The opposite end is held by a spring with a force of 10 newtons. What force at point F is required to unbalance the beam and activate the microswitch?

Simple Machines ☑

15. Read the scenario in the picture below, then find the angle indicated Round answer to two significant figures. ☐

Select the answer from the list below.



Components travelling on a conveyor at a constant speed of 20 m/min need to be ink jet labelled by a robot.

The robot arm can move at 75 m/min at right angles to the conveyor.

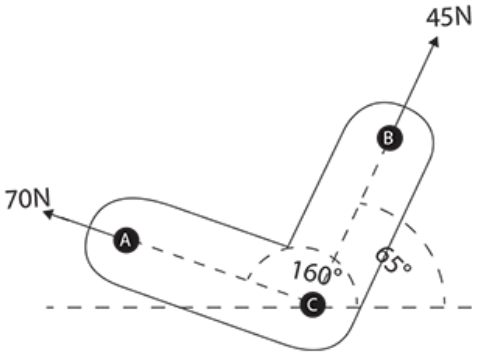
Use vectors to work out the angle the products have to be placed on the conveyor to keep the label straight.

- ☐ 10°
- ☐ 15°
- ☐ 30°
- ☐ 45°
- ☐ 75°
- ☐ 80°

16. The linkage in the picture below has two forces acting on it. The forces and angles on A and B can be added together to work out the force and direction at pin C. ☐

Find the resultant force (magnitude to the nearest whole number and angle to the nearest 5°).

Select the answer from the list below.



- ☐ 87 N (angle 30°)
- ☐ 115 N (angle 225°)
- ☐ 70 N (angle 95°)
- ☐ 80 N (angle 125°)
- ☐ 115 N (angle 85°)

Simple Machines ☑

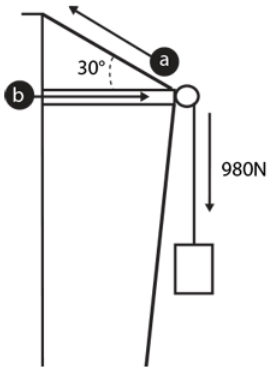
17. Read the scenario in the picture below, then find the resultant forces on a and b. ☐

Select the answer from the list below.

This crane is lifting a load using a winch.

The load on the winch equals the load on the support wire (load plus weight of beam).

Use a vector diagram to calculate the load on the beam.



- ☐ a = 980 N b = 980 N
- ☐ a = 1700 N b = 1960 N
- ☐ a = 1960 N b = 1700 N
- ☐ a = 1960 N b = 1960 N
- ☐ a = 1700 N b = 720 N

Friction ☑

18. Select whether the following statement is True or False. ☐

"The 'coefficient of friction' refers to the frictional value of two materials sliding over each other."

- ☐ True
- ☐ False

19. Select whether the following statement is True or False. ☐

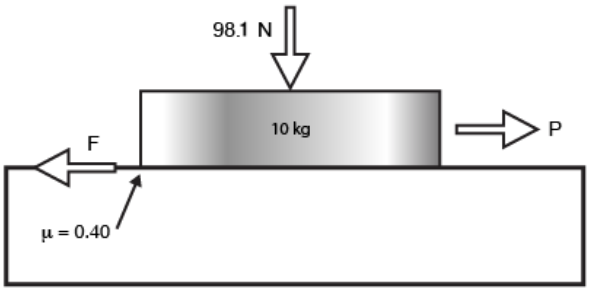
"The value of the coefficient of friction is always the same. It does not depend on the type of materials that are in contact."

- ☐ True
- ☐ False

Friction ☑

20. Read the scenario in the picture below, then calculate force P in Newtons that is required to overcome F and start the block moving. Round your answer to one decimal place. ☐

Formula: Static friction = force (N) x coefficient of friction (μ)

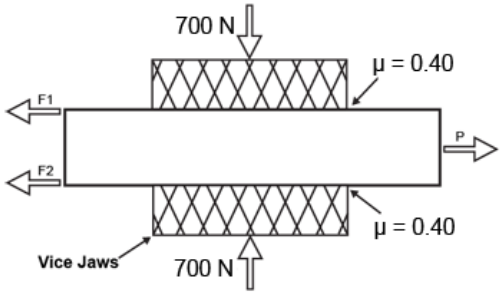


Force = N

A steel block is sitting on a flat surface with a coefficient of friction of 0.4.

21. Read the scenario in the picture below, then calculate force P in Newtons that is required to overcome the combined friction of F_1 and F_2. ☐

Formula: Static friction = force (N) x coefficient of friction (μ)



Force = N

This is a piece of flat metal clamped in the jaws of a vice.

Calculate the maximum force that can be applied on direction P before the piece of metal will start to move.

Friction ☑

22. For each description below, select the correct friction type. ☐

Description	Type of friction
The value of the frictional force after slipping has occurred. It is the resistance to continued motion.	☐ Kinetic friction/ ☐ Rolling friction/ ☐ Sliding friction/ ☐ Static friction
The friction between two surfaces sliding over each other.	☐ Kinetic friction/ ☐ Rolling friction/ ☐ Sliding friction/ ☐ Static friction
The friction between the bearing surface and ball or roller bearings. Generally much lower than sliding friction (typically only 1% of dry friction).	☐ Kinetic friction/ ☐ Rolling friction/ ☐ Sliding friction/ ☐ Static friction
This is the value of the frictional force just before slipping occurs.	☐ Kinetic friction/ ☐ Rolling friction/ ☐ Sliding friction/ ☐ Static friction

23. From the statements below, select **three advantages** of friction in engineering applications. ☐

- ☐ Enables clutches, brakes and pulley belts to function properly.
- ☐ Loss of energy.
- ☐ Stops overheating.
- ☐ Enables the locking action of threads and rivets.
- ☐ Provides grip for vehicles on the road.

Friction	☑
24. From the statements below, select **three disadvantages** of friction in engineering applications. ☐ Provides grip for vehicles on the road. ☐ Overheating. ☐ Loss of energy. ☐ Stops nuts from undoing. ☐ Causes wear.	☐
25. From the statements below, select the **five** best methods of reducing friction that can be built into the design of the machine. ☐ Using suitable materials on moving surfaces. ☐ Keeping bearing surfaces clean. ☐ Lubrication systems. ☐ Using the correct lubricant. ☐ Using slides or rollers, e.g. ball bearings. ☐ Using other materials between surfaces. ☐ Using smooth bearing surfaces. ☐ Lubricating bearing surfaces. ☐ Adjusting slide and bearing clearances. ☐ Using clean lubricants	☐

Friction ☑

26. From the statements below, select the **five** best methods of reducing friction that are under operator control. ☐

- ☐ Using the correct lubricant.
- ☐ Keeping bearing surfaces clean.
- ☐ Using clean lubricants.
- ☐ Using suitable materials on moving surfaces.
- ☐ Using smooth bearing surfaces.
- ☐ Lubricating bearing surfaces.
- ☐ Adjusting slide and bearing clearances.
- ☐ Using slides or rollers, e.g. ball bearings.
- ☐ Using other materials between surfaces.
- ☐ Lubrication systems.

Pascal's Law ☑

27. Select whether the following statement is True or False. ☐

"Pascal's law states that pressure applied to a confined fluid is transmitted undiminished in all directions."

- ☐ True
- ☐ False

28. Select which of the following is **not** an example of an application of Pascal's law in mechanical engineering. ☐

- ☐ Pulley
- ☐ Hydraulic braking systems
- ☐ Water blaster
- ☐ Hydraulic jack
- ☐ Hand pump

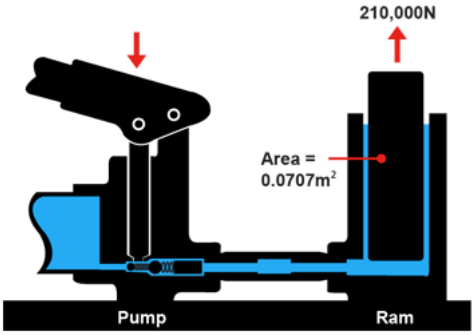
Pascal's Law ☑

29. Read the scenario in the picture below, then calculate the pressure in the oil in **MPa**. Round your answer to two decimal places. ☐

Formula: Pressure in the oil (Pa) = $\frac{\text{force on ram (N)}}{\text{area of ram}(m^2)}$

A hydraulic jack is operated by a hand lever.

Pressure = MPa



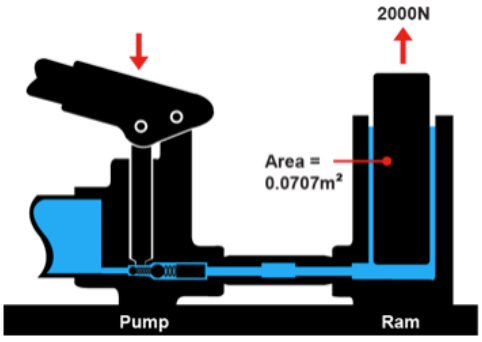
The ram has a diameter of 300mm giving it a surface area of 0.0707 m^2. The load on the ram is 210,000N.

30. Read the scenario in the picture below. If the load on the ram is decreased to 2000N, calculate the pressure in the oil in **kPa**. Round your answer to two decimal places. ☐

Formula: Pressure in the oil (Pa) = $\frac{\text{force on ram (N)}}{\text{area of ram}(m^2)}$

A hydraulic jack is operated by a hand lever.

Pressure = kPa



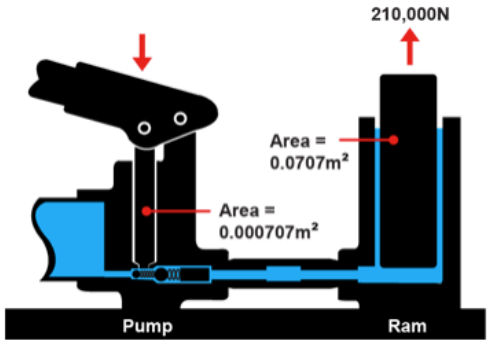
The ram has a diameter of 300mm giving it a surface area of 0.0707 m^2. The load on the ram is 2,000N.

Pascal's Law ☑

31. Read the scenario in the picture below, then calculate the direct force in Newtons required on the pumping piston to balance the load on the ram. ☐

Formula: $$\frac{\text{force on piston (N)}}{\text{area of piston } (m^2)} = \frac{force\ on\ ram\ (N)}{area\ of\ ram\ (m^2)}$$

A hydraulic jack is operated by a hand lever.



The pumping piston has a diameter of 30mm (surface area 0.000707 m^2) and the ram has a diameter of 300mm (surface area 0.0707 m^2). The load on the ram is 210,000 N.

Force = N

You have reached the end of the questions.

Candidate evidence check

Required evidence
Use this checklist to make sure you finished the assessment tasks in full. Clearly name and label all attachments. You must have completed all assessment tasks yourself, used your own words, and any completed work you attach is your own. **I have completed and/or attached:** ☐ The Questions in this guide.
Additional supporting evidence
If you have any other evidence which helps prove your skills and knowledge in this unit (such as completed documents, photos, videos or voice recordings), attach it and record it below. Clearly name and label all attachments. I have attached the following as additional supporting evidence:

Assessor final judgement

After reviewing the candidate's evidence for Unit Standard 21908 v3, it is clear that the candidate can competently:

- ☐ Demonstrate knowledge of simple machines.
- ☐ Demonstrate knowledge of friction.
- ☐ Demonstrate knowledge of Pascal's Law.

Assessor feedback to the candidate			
Assessor		**Date**	