

Engineering Questions by Topic

Higher Level

Question 2

Materials Testing & NDT

50 Marks



1996 Question 2

- (a) (i) Distinguish between macroscopic and microscopic examination of metallic materials.
- (ii) Explain any two of the following terms: elastic limit; tensile strength; proof stress.
- (b) A tensile test on an alloy gave the following results:-

Stress (N/mm ²)	68	135	200	275	308	325	338	350
Strain (x 1000)	0.75	1.50	2.25	3.25	4	4.75	5.5	7.25

Plot the stress-strain graph and use the graph to find:-

- (i) 0.2% proof stress;
- (ii) Young's Modulus of elasticity for the alloy.
- (c) Explain the principle of any two of the following non-destructive tests:
- (i) liquid penetrant test;
- (ii) radiography test;
- (iii) eddy-current test.

In each case state whether the test is suitable for detecting internal or external flaws.

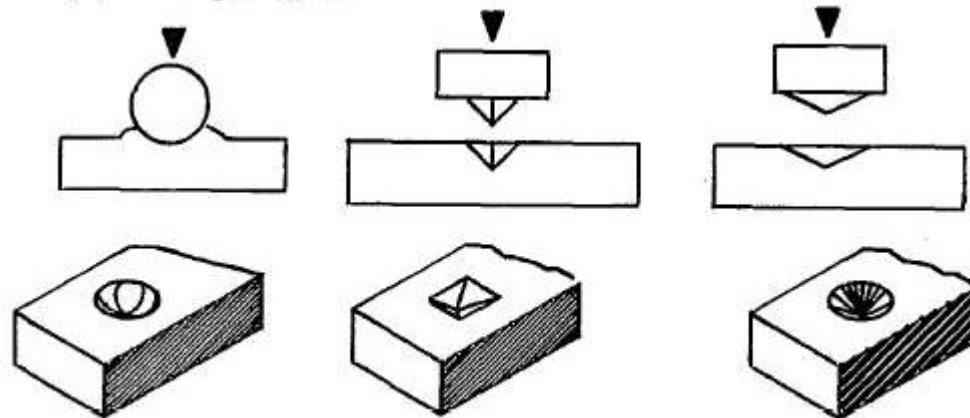
1997 Question 2

- (a) (i) List three elements of poor design that may contribute to early failure in components.
(ii) Describe a test procedure based on *Pulse Reflection*.

(b) Explain the principles of any two of the tests shown below.

Refer in particular to:

- (i) Basis for results;
(ii) Specific name of test;
(iii) Distinguishing features.





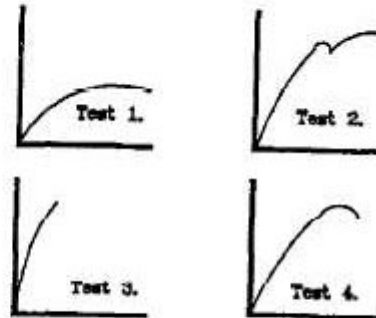
1997 Question 2 cont.

- (c) Identify the type of non-destructive test most suitable for each of the following defects.
- (i) Surface cracks in Ferro-Magnetic materials;
 - (ii) Internal flaws in welds;
 - (iii) Surface cracks in Non-Ferrous materials.

1998 Question 2

(a) The results of four separate tensile tests are shown in graphical form. Discuss the results using the following guidelines:

- (i) properties of each sample tested;
- (ii) type of materials.



(b) Compare two toughness tests referring to:

- (i) test arrangement;
- (ii) energy utilised.

1998 Question 2 cont.

- (c) (i) A non-destructive test is represented diagrammatically in Fig. 2. Outline the principles of the test and suggest a suitable application.

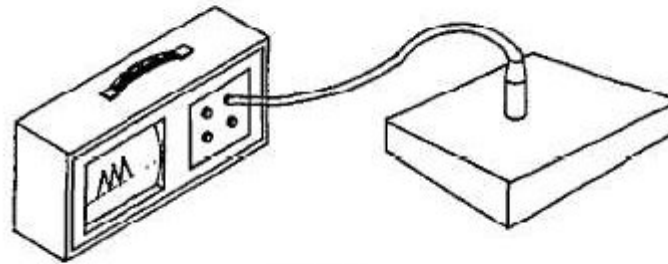
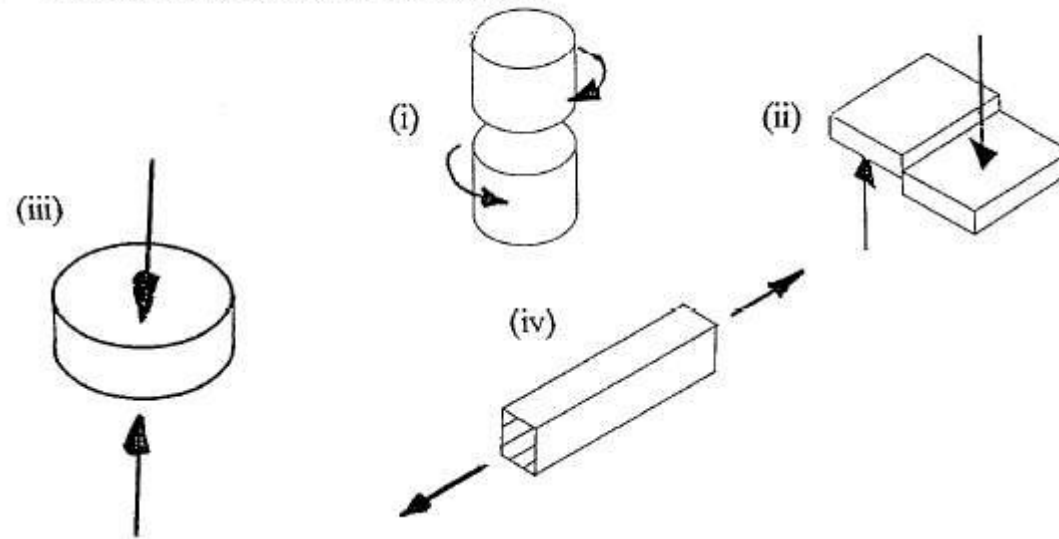


FIG. 2

- (ii) Compare eddy current testing with the magnetic particles test. Suggest a suitable application for each test.

1999 Question 2

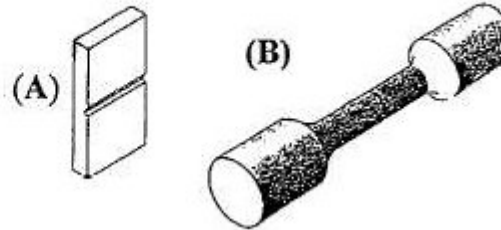
(a) Distinguish clearly between the following forces:



1999 Question 2 cont.

(b) Two common test specimens are shown at A and B. Select one specimen and describe fully the test associated with it using the following guidelines:

- (i) Test name and purpose;
- (ii) Test procedure;
- (iii) Results.



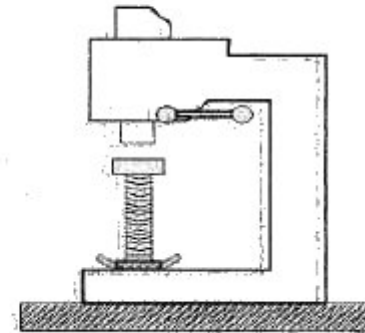
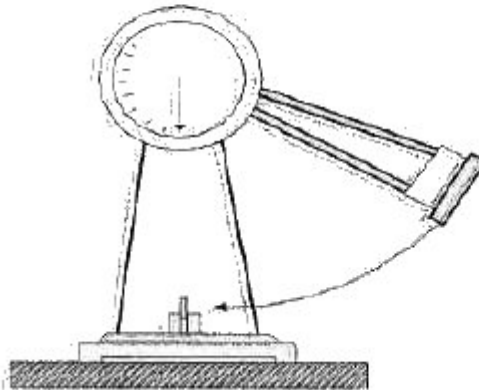
(c) Describe the principles of any two of the following non-destructive tests:

- (i) Ultrasonic;
- (ii) Magnetic;
- (iii) Radiographic.

In each case selected, state its suitability for the detection of internal or external faults.

2000 Question 2

- (a) (i) State **three** reasons for testing materials mechanically.
- (ii) Outline the principles of **any one** test associated with **one** of the testing machines shown below.





2000 Question 2 cont.

- (b) The following data was obtained in a tensile test on a specimen of 12 mm diameter and of 50 mm gauge length.

Load (kN)	20	65	90	110	128	147	183	197	194	180
Extension (mm)	0.10	0.30	0.40	0.50	1.00	2.00	5.00	8.00	11.5	14.0

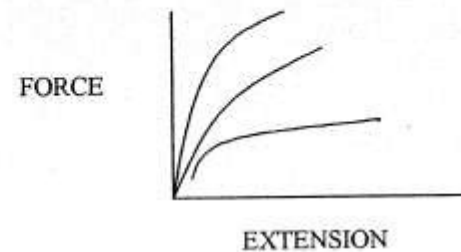
Plot the load / extension graph and determine:

- (i) The tensile strength.
 - (ii) The 0.1% proof stress.
- (c) Explain why non-destructive tests are needed in industry.
Describe briefly one non-destructive test you have studied.

2001 Question 2

- (a) The force-extension graphs for three non-ferrous metals are shown. Redraw the graphs into your answer book matching the metals listed below with a corresponding graph and briefly outline the ductility of each.

- (i) Soft Copper;
- (ii) Aluminium;
- (iii) Soft Brass.

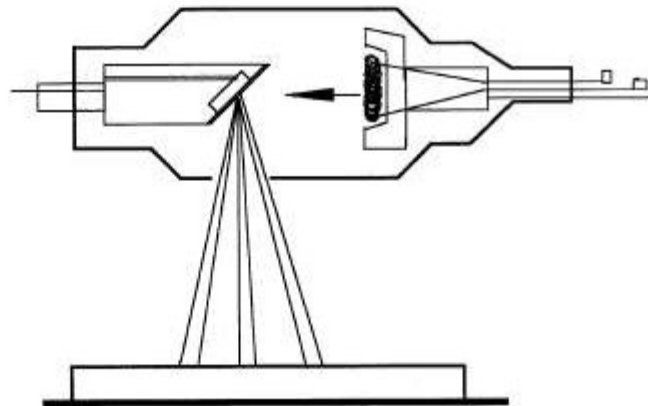


- (b) Answer **each** of the following.

- (i) Define **any two** of the following.
Malleability; Toughness; Hardness; Youngs Modulus of Elasticity.
- (ii) Suggest a suitable inspection technique for detecting the following defects.
Internal cavities in aluminium castings; Surface cracks in cast iron plates; Internal faults in welding joints.

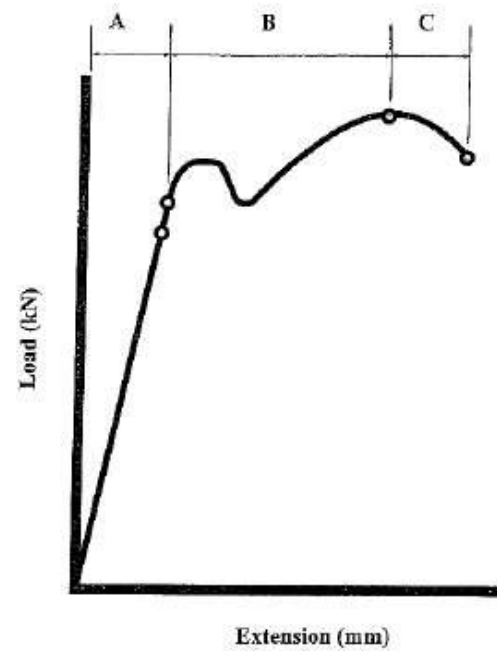
2001 Question 2 cont.

- (c) A non-destructive test is represented diagrammatically in the drawing below.
- (i) Name the test;
 - (ii) Outline the principles of operation;
 - (iii) Suggest a suitable application.



2002 Question 2

- (a) (i) In the Load-Extension graph below describe the ranges A, B and C.

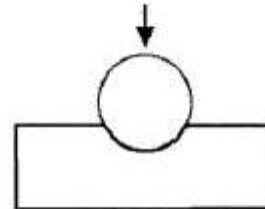


- (ii) What is fatigue failure?

2002 Question 2 cont.

(b) Explain any test based on the diagram below using the following guidelines:

- (i) Name and purpose of test;
- (ii) Test procedures;
- (iii) Expected results.



(c) Describe the principles and applications of any two of the following tests:

- (i) Ultrasonic;
- (ii) Radiographic;
- (iii) Magnetic.



2003 Question 2

- (a) (i) Explain the term *creep* with reference to metals.
- (ii) State **two** factors that affect the behaviour of *creep* in metals.
- (b) A tensile test on a specimen material gave the following results:

Stress (N/mm^2)	44	110	220	264	300	330	340	352
Strain (x 1000)	0.50	1.25	2.50	3.00	3.75	5.00	5.75	7.50

Using the graph paper supplied, plot the stress-strain graph and determine:

- (i) The 0.2% proof stress;
- (ii) Young's Modulus of Elasticity for the material.
- (c) (i) Name **two** non-destructive tests used to detect internal flaws in metals.
- (ii) Describe, with the aid of a diagram, **one** of these tests.

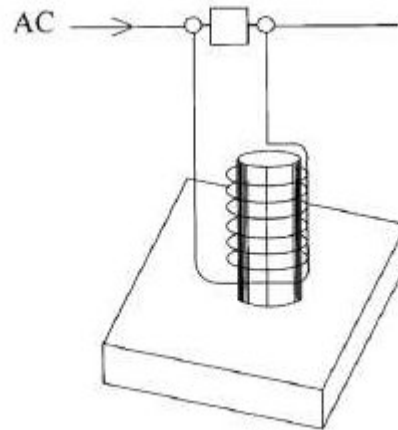


2004 Question 2

- (a) Differentiate between any two of the following in relation to materials testing:
- (i) Ductile fracture and brittle fracture;
 - (ii) Macroscopic and microscopic examination of materials;
 - (iii) Fatigue and creep;
 - (iv) Izod and Charpy.
- (b) Describe the Vickers hardness test using the following guidelines:
- (i) The principle of the test;
 - (ii) The type of indenter used;
 - (iii) An advantage of this test.

2004 Question 2 cont.

- (c) A non-destructive test is represented in the drawing below:
- (i) Name the test;
 - (ii) Outline the principle of operation;
 - (iii) Suggest a suitable application.





2005 Question 2

- (a) With reference to impact testing, describe **each** of the following:
- (i) Testing procedure;
 - (ii) Izod method;
 - (iii) Charpy method.

- (b) A tensile test on a specimen gave the following results.

Stress (N/mm ²)	68	135	200	275	308	325	338	350
Strain (x 1000)	0.75	1.50	2.25	3.25	4.00	4.75	5.50	7.25

Using the graph paper supplied, plot the stress-strain diagram and determine:

- (i) The 0.2% proof stress;
 - (ii) Young's Modulus of Elasticity for the material.
- (c) Describe the non-destructive tests most suitable for **each** of the following defects:
- (i) Surface flaws in non-ferrous materials;
 - (ii) Internal flaws in welds.



2006 Question 2

- (a) Answer any two of the following:
- (i) Compare the indenters used in Brinell and Vickers hardness tests;
 - (ii) With reference to tensile testing, explain the elastic limit of a material;
 - (iii) Identify two factors necessary to prevent early fatigue failure in a component.
- (b) The following data was obtained from a tensile test on a specimen of 10mm diameter and gauge length 60mm.

Load (kN)	16	32	56	72	95	110	132	142	140	135
Extension (mm)	0.2	0.4	0.7	0.9	1.5	2.5	5.0	8.5	10.0	12.0

Using the graph paper supplied, plot the load-extension diagram and determine:

- (i) The tensile strength;
- (ii) Young's Modulus for the specimen.

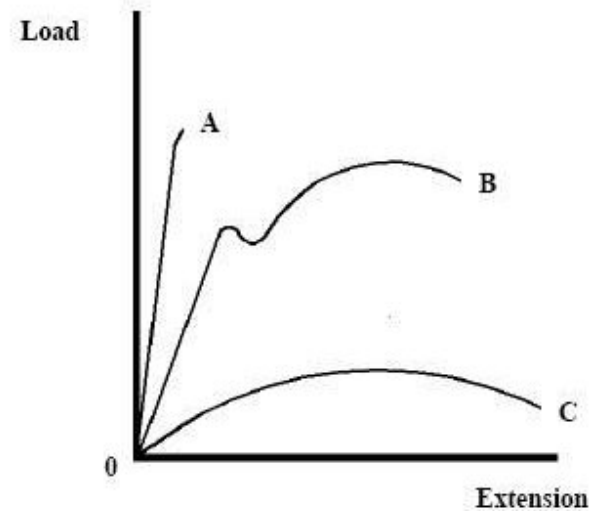


2006 Question 2 cont.

- (c) (i) State **two** reasons why non-destructive tests are necessary in industry.
- (ii) Describe, with the aid of a diagram, a test suitable for the detection of internal flaws.

2007 Question 2

- (a) (i) What are the advantages of mechanical testing?
- (ii) Compare Izod and Charpy impact tests.
- (b) (i) Identify the basic information that can be obtained from a tensile test.
- (ii) With reference to the graph shown below, outline the properties associated with materials A, B and C.





2007 Question 2 cont.

- (c) (i) Why are non-destructive tests used in the manufacture of engine parts?
- (ii) Describe, with the aid of a diagram, a suitable non-destructive test for assessing welds for internal faults.



2008 Question 2

- (a) Answer any two of the following:
- (i) Distinguish between microscopic and macroscopic examination of metals;
 - (ii) With reference to metals, explain the term *creep*. Identify two factors that influence *creep*;
 - (iii) Compare the indenters used in both the Brinell and the Vickers hardness tests.
- (b) The following data were obtained from a tensile test on a specimen of an aluminium alloy.

Stress (N/mm^2)	50	125	195	260	300	330	350	352
Strain (x1000)	0.60	1.40	2.20	3.00	3.70	5.00	7.00	8.50

Using the graph paper supplied, plot the stress-strain diagram and then determine:

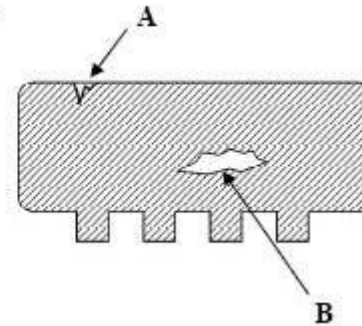
- (i) The 0.1% proof stress;
- (ii) Young's Modulus of Elasticity for the specimen.

2008 Question 2 cont.

(c) The iron casting illustrates two defects at A and B.

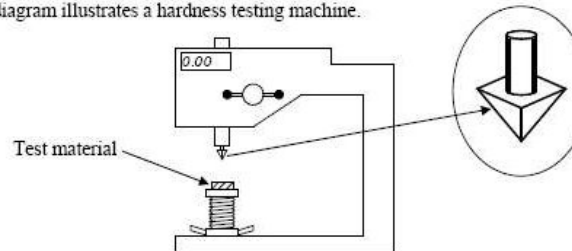
(i) Identify suitable non-destructive tests to determine the defects shown at A and B.

(ii) Describe, with the aid of a diagram, the test identified to locate the defect at B.



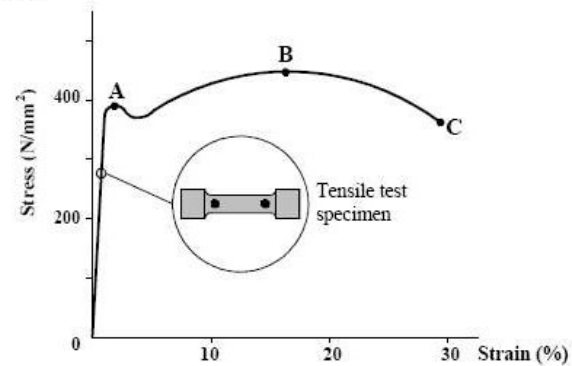
2009 Question 2

(a) The diagram illustrates a hardness testing machine.



- Identify the hardness test shown.
- Describe the main features of this mechanical test.

(b) The Stress-Strain graph and the test specimen used in a tensile test are shown.



- Identify the points A, B and C on the Stress-Strain graph.
- Describe, with the aid of diagrams, the shape of the test specimen at point B and the shape of the test specimen at point C.

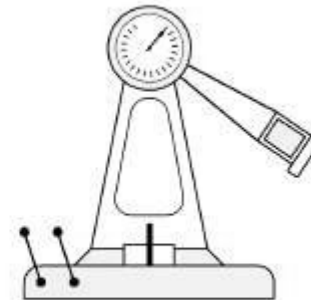


2009 Question 2 cont.

- (c) (i) Outline **two** reasons why non-destructive tests are used in the manufacture of cast motorcycle engines.
- (ii) Describe, with the aid of a suitable diagram, a non-destructive test for locating surface flaws on aluminium castings.

2010 Question 2

- (a) (i) Outline **two** reasons for the mechanical testing of metals to the point of destruction.
- (ii) Describe the main features of the mechanical test represented in the diagram, with reference to the following:
- Purpose of the test
 - Principle of operation.



- (b) The following results were obtained from a tensile test on a cold-worked brass specimen. The test specimen was 16 mm in diameter with a gauge length of 80 mm.

Load (kN)	23	46	69	82	89	94	102	110	123	131	136	139	132	118
Extension(mm)	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.5	2.0	2.5	3.0	4.0	4.3

Using the graph paper supplied, plot the load-extension diagram and determine:

- (i) The ultimate tensile strength (UTS);
- (ii) The 0.1% proof stress.

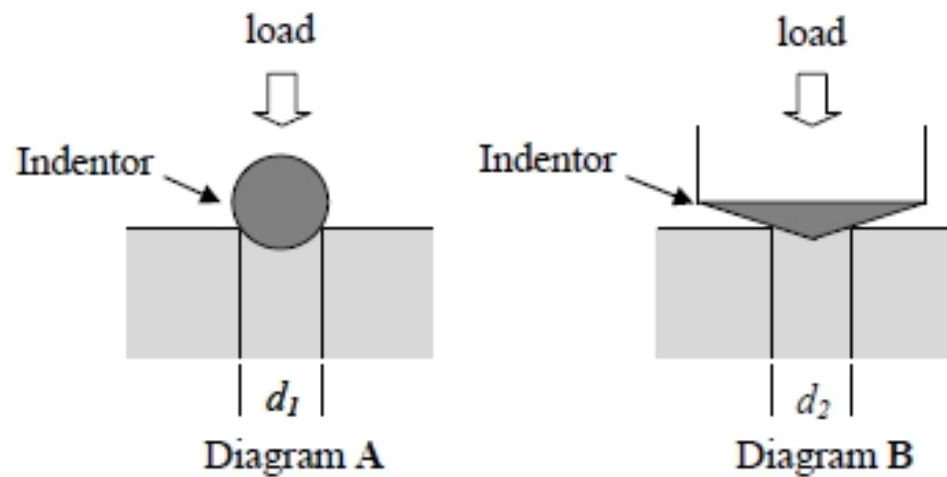


2010 Question 2 cont.

- (c) Describe, with the aid of suitable diagrams, each of the following non-destructive tests (NDT):
- (i) Eddy current testing;
 - (ii) Radiography (x-ray) testing.

2011 Question 2

- (a) (i) Distinguish between *metal fatigue* and *metal creep*.
- (ii) Compare the two hardness tests represented in diagrams A and B, making reference to:
- name of tests
 - method of measurement
 - test-material suitability.





2011 Question 2 cont.

- (b) The following results were obtained from a tensile test on an aluminium alloy.

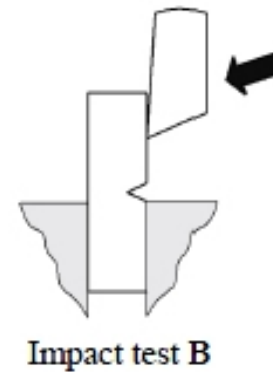
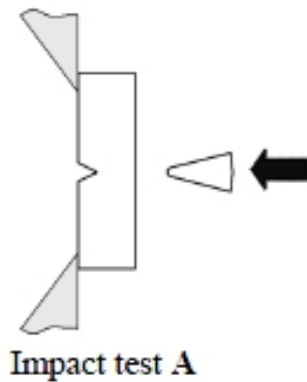
Stress (N/mm ²)	44	110	220	264	300	330	340	352
Strain (×1000)	0.5	1.25	2.5	3.0	3.75	5.0	5.75	7.5

Using the graph paper supplied, plot the stress-strain graph and determine:

- (i) Young's modulus of elasticity for the alloy;
 - (ii) The 0.1% proof stress.
- (c)
- (i) Non-destructive tests (NDTs) are generally more expensive than other forms of metal testing. Explain two reasons for the use of NDTs in industry.
 - (ii) Describe, with the aid of a suitable diagram, one non-destructive test that uses ultrasonic principles as a method of flaw detection.

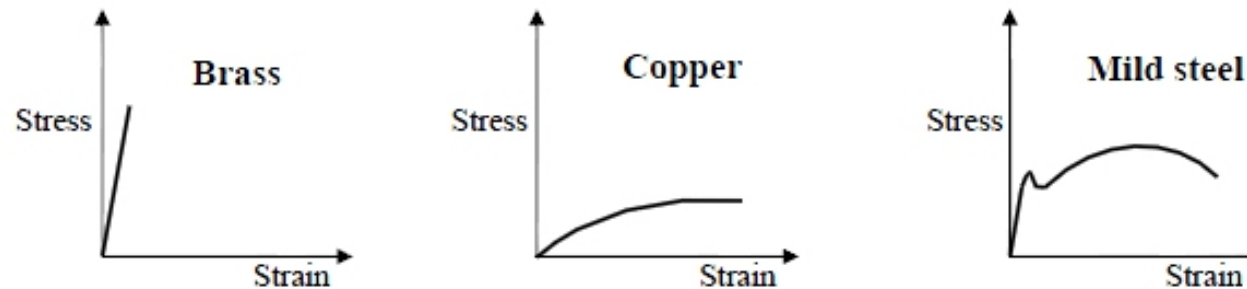
2012 Question 2

- (a) (i) Describe the principle of operation of **any one** impact test.
(ii) Compare the two impact tests represented in diagrams A and B.



2012 Question 2 cont.

- (b) The results shown below were obtained from a series of tensile tests on the following metals: **Brass**, **Copper** and **Mild steel**.



- (i) Describe the degree of brittleness in each of the metals shown.
- (ii) Explain the difference between the elastic state and the plastic state when mild steel is subjected to a tensile test.



2012 Question 2 cont.

- (c) (i) In the manufacture and maintenance of aircraft, a range of non-destructive testing (NDT) is used to check for internal and external flaws.
Identify **two** NDTs that examine surface imperfections and **two** NDTs that detect internal flaws.
- (ii) Describe, with the aid of suitable diagrams, **one** non-destructive test used to check for internal faults in welded joints.



2013 Question 2

(a) (i) Distinguish clearly between *fatigue* and *creep* with reference to deformation of metals.

(ii) Mechanical tests are carried out to determine metal properties.

These include:

A - Tensile test;

B - Vickers test;

C - Izod test.

For each of the tests A, B and C, identify and describe the metal properties under examination.



2013 Question 2 cont.

- (b) The results shown below were obtained from a tensile test on a non-ferrous alloy with a 10 mm diameter and 50 mm gauge length.

Load (kN)	15	25	40	60	80	100	107	108	105	96
Extension (mm)	0.06	0.10	0.16	0.26	0.38	0.65	0.90	1.00	1.20	1.40

Using the graph paper supplied, plot the load-extension diagram and determine:

- (i) The ultimate tensile strength (UTS);
- (ii) The 0.1% proof stress.

2013 Question 2 cont.

- (c) (i) Outline **three** advantages of using non-destructive tests (NDT) in industrial engineering.
- (ii) Name the NDT shown below. Describe the principle of operation and the applications of this NDT.

