basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

MECHANICAL TECHNOLOGY

EXEMPLAR 2016

MEMORANDUM

MARKS: 200

This memorandum consists of 26 pages.

SECTION A (GENERIC)

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1	C✓	(1)
1.2	C✓	(1)
1.3	D✓	(1)
1.4	C✓	(1)
1.5	B✓	(1)
1.6	B✓	(1)
1.7	C✓	(1)
1.8	A✓	(1)
1.9	B✓	(1)
1.10	A✓	(1)
1.11	B✓	(1)
1.12	A✓	(1)
1.13	B✓	(1)
1.14	D✓	(1)
1.15	A✓	(1)
1.16	A✓	(1)
1.17	A✓	(1)
1.18	D✓	(1)
1.19	B✓	(1)
1.20	A✓	(1)

[20]

QUESTION 2: SAFETY (GENERIC)

2.1 **Personal protective items:**

- Safety goggles✓
- Apron or overall✓
- Safety boots✓
- Hair net✓
- Gloves✓

(Any 3 x 1) (3)

2.2 **Safety precautions when using drill press:**

- Choose correct sharpened drill.✓
- Do not leave the chuck key on the chuck.✓
- Ensure that clamp is clamped securely.✓
- Choose the correct speed for the material.✓

(Any 2 x 1) (2)

2.3 **Milling machine safety:**

- Never apply a wrench to a revolving work piece.✓
- Do not use your hands to remove cuttings.✓
- Never adjust a cutting tool while in operation.✓
- Do not attempt to stop the machine by placing a hand on the chuck.✓
- Pay attention to cutting fluid for splashing.✓

(Any 3 x 1) (3)

2.4 **Procedure after using lathe:**

- Switch off the machine✓ (1)

2.5 **Fire extinguisher:**

- Dry powder✓
- Foam✓
- Carbon dioxide✓
- Vaporising liquids✓

(Any 1 x 1) (1)
[10]

QUESTION 3: TOOLS AND EQUIPMENT (GENERIC)

3.1 **File profiles:**

- Smooth✓
- Second cut✓
- Bastard cut✓

(Any 2 x 1) (2)

3.2 **Advantage of open-ended spanner over ring spanner:**

- Can be used in confined space where ring spanner cannot fit.✓ (1)

3.3 **Types of pliers:**

- Combination pliers✓
- Diagonal pliers✓
- Long nose pliers✓
- Circlip pliers✓
- Water pump pliers✓
- Vice grip pliers✓

(Any 2 x 1) (2)

3.4 **Phillips screwdriver**:

- Contact area is larger✓
- Does not slip from the groove ✓ (2)

3.5 **Combination set:**

- Testing external angle✓
- Testing internal angle✓
- Testing 45° work piece✓
- Used as depth gauge✓
- Determining incline of work piece✓
- Determining the centre of a round work piece✓

(Any 3 x 1) (3)

3.6 **Uses of punches:**

3.6.1 **Prick punch:**

- To mark or pop scribed lines to make them more prominent.✓
- To indicate the centre of a circle.✓

(Any 1 x 1) (1)

3.6.2 **Centre punch:**

- To enlarge the pop mark on a surface where a hole has to be drilled.✓ (1)

[12]

QUESTION 4: MATERIALS (GENERIC)

4.1 **Carbon steel**:

- Low-carbon steel✓
- Medium-carbon steel✓
- High-carbon steel✓ (3)

4.2 **Cast iron:**

- The amount of carbon content in the cast iron.✓✓ (2)

4.3 **Non-ferrous elements:**

4.3.1 **Copper:**
cables, telephone wires, bus bars, soldering irons, electric wiring, water pipes and roofing✓

(Any 1 x 1) (1)

4.3.2 **Tin:**
soft solder, tin cans, cladding of steel sheeting, protective coating for copper wires, part of alloys like brass and bronze, basis of white metal bearings✓

(Any 1 x 1) (1)

4.3.3 **Aluminium:**
cooking utensils, foil and electrical conductors✓

(Any 1 x 1) (1)

4.4 **Non-ferrous alloys:**

- Brass✓
- Bronze✓
- Phosphor bronze✓
- White metal✓
- Duralumin✓
- Solder✓

(Any 4 x 1) (4)
[12]

QUESTION 5: JOINING METHODS (GENERIC)

5.1 **Tap sequence:**

- Taper✓
- Second✓
- Bottoming✓

Answer may also be No. 1, 2 and 3. (3)

5.2 **Inferior results of hand threading:**

- Blunt taps✓
- Incorrect size tapping hole✓
- Tap not square to the hole✓
- Insufficient or incorrect tapping compound✓
- Build-up of swarf (chips) in the hole✓
- Too much force used on the tap✓

(Any 3 x 1) (3)

5.3 **Die:**
The purpose of die is to cut external screw threads.✓✓ (2)

5.4 **Key calculations:**

5.4.1 **The width of the parallel key:**

$$\text{Width of parallel key} = \frac{\text{diameter of shaft}}{4} \quad ✓$$

$$= \frac{42}{4} \quad ✓$$

$$= 10{,}5\ \text{mm} \quad ✓$$

(3)

5.4.2 **The thickness of the parallel key:**

$$\text{Thickness of parallel key} = \frac{\text{diameter of shaft}}{6} \quad ✓$$

$$= \frac{42}{6} \quad ✓$$

$$= 7\ \text{mm} \quad ✓$$

(3)

5.4.3 **The length of the parallel key:**

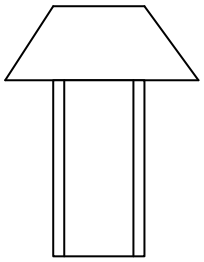
Length of the key = 1,5 x diameter of a shaft✓
= 1,5 x 42 mm✓
= 63 mm✓ (3)

5.5 **Calculation of drill bit:**

Drill bit = tap size – pitch✓
= 16 – 2✓
= 14 mm✓ (3)

5.6 **Sketches of rivet heads:**

5.6.1 **Pan head:**

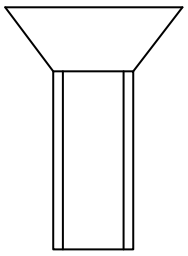


✓

✓

(2)

5.6.2 **Countersunk head:**



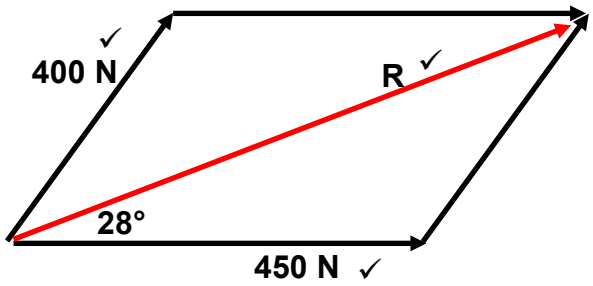
✓

✓

(2)
[24]

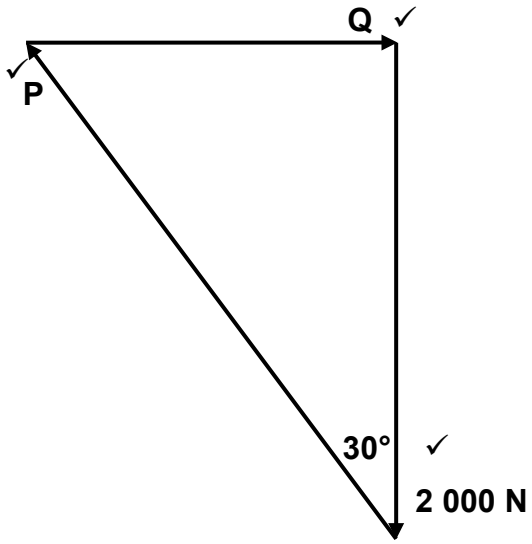
QUESTION 6: FORCES (GENERIC)

6.1 Scale 1 mm = 5N



R = 147 mm = 735 N 28° north from east ✓ (4)

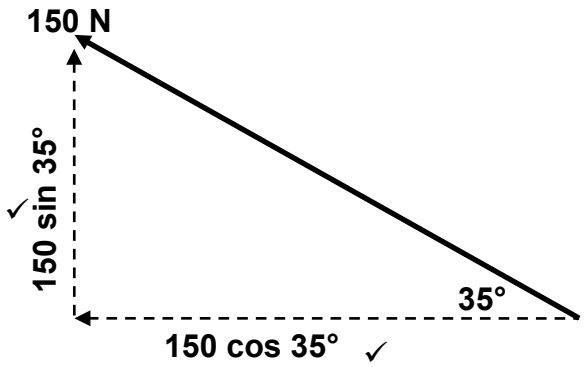
6.2 **Vector diagram: Scale 1 mm = 20 N**



P = 115 mm = 2 300 N ✓
Q = 58 mm = 1 160 N ✓ (5)

6.3 **Force definition:**
A force is the influence✓ that changes✓ or tends to change✓ the state of rest✓ and/or uniform movement✓ of a body in a straight line.✓ (5)

6.4 **Horizontal and vertical components of this force:**



HC = 150 cos 35° ✓
= 122,87 N West ✓

VC = 150 sin 35° ✓
= 86,04 N North ✓ (4)

6.5 **Stress:**

$$A = \frac{\pi D^2}{4} \quad \checkmark$$
$$= \frac{\pi(0,015)^2}{4}$$
$$= 0,18 \times 10^{-3} m^2 \quad \checkmark$$

OR

$$\sigma = \frac{F}{A} \quad \checkmark$$
$$= \frac{30 \times 10^3}{0,18 \times 10^{-3}} \quad \checkmark$$
$$= 166,67 \times 10^6 \text{ Pa}$$
$$= 166,67 \text{ MPa} \quad \checkmark$$ (5)

6.6 **Moments:**

$$T = (190 \times 0,35) + (170 \times 1) \quad \checkmark\checkmark$$
$$= 66,5 + 170 \quad \checkmark$$
$$= 236,5 \text{ N.m} \quad \checkmark$$ (4)

[27]

QUESTION 7: MAINTENANCE (GENERIC)

7.1 **Lack of maintenance:**

- More energy will be used✓
- Malfunctioning of parts and machinery✓
- Level of production will decrease✓
- Worn parts or machine will have to be replaced✓

(Any 4 x 1) (4)

7.2 **Types of maintenance:**

7.2.1 **Preventative maintenance:**

- Maintenance of equipment and facilities in a satisfactory operating condition by providing systematic inspection and correction of emerging failures before they develop into major defects✓, e.g. servicing of a motor vehicle.✓ (2)

7.2.2 **Predictive maintenance:**

- Evaluation of equipment's condition by performing periodic✓ or continuous equipment condition monitoring (also referred to as condition-based maintenance), e.g. using principle of statistical process control to determine at what point in the future maintenance activities will be appropriate.✓ (2)

7.3 **Purpose of a lubricant:**

- It prevents corrosion.✓
- It controls contamination within systems.✓
- It assists in temperature control by absorbing heat.✓
- It reduces friction and wear.✓

(Any 3 x 1) (3)

7.4 **Viscosity:**

- Viscosity refers to the resistance of oil to flow.✓ (1)

7.5 **Viscosity of types of lubricants:**

7.5.1 **Engine oil:**

- Engine oil has medium viscosity SAE 20W-50 because it should be able to flow under all engine operating conditions (during warm, cold or hot temperatures).✓✓ (2)

7.5.2 **Grease:**

- Grease has high viscosity✓ so that it can maintain its adhesive qualities under operating temperatures and stick to the surface it is lubricating.✓ (2)

[16]

QUESTION 8: ENGINES (GENERIC)

8.1 **Engine terms:**

8.1.1 **Stroke:**

- The stroke of an engine is the distance that the piston travels in the cylinder from one extreme position to the other (from TDC to BDC or vice versa).✓ (1)

8.1.2 **Top dead centre:**

- This refers to the exact spot where the crankshaft, with the aid of the piston and connecting rod, transforms the upward movement of the piston into a downward movement.✓ (1)

8.1.3 **Cycle:**

- A cycle consists of four strokes, namely the inlet stroke, the compression stroke, the power stroke and the exhaust stroke.✓ (1)

8.2 **Two-stroke petrol engine:**

8.2.1 **Label:**

A. Transfer port✓
B. Deflector✓
C. Exhaust port✓
D. Inlet port✓ (4)

8.2.2 **Operation:**

Inlet phase

- When the piston moves upwards, the volume of the crankcase enlarges systematically, creating a partial vacuum in the crankcase.✓
- As soon as the piston moves past the inlet port (D), a mixture of air, fuel and oil streams into the crankcase.✓

Compression phase

- The air and fuel mixture which was transferred to the top end of the piston during the previous stroke is now compressed.✓
- Just before the piston reaches top dead centre, the compressed mixture is ignited by an electric spark.✓ (4)

8.3 **Four-stroke petrol engine:**

8.3.1 **The stroke:**

- Inlet stroke✓ (1)

8.3.2 **Labelling:**

A – Inlet valve, open ✓
B – Air-fuel mixture✓
C – Piston movement from BDC to TDC✓ (3)

8.3.3 **Operation:**

- The induction stroke starts when the piston in the cylinder moves from top dead centre to bottom dead centre.✓
- The exhaust valve is closed and the inlet valve is opened by the cam, which rotates at half the speed of the crankshaft.✓
- The downward movement of the piston causes a vacuum in the cylinder.✓ As a result, a mixture of fuel and air streams from the carburettor into the cylinder.✓ (4)

[19]

TOTAL SECTION A: 140

SECTION B: FITTING AND MACHINING(SPECIFIC)

QUESTION 9: TERMINOLOGY (SPECIFIC)

9.1 **Vernier calliper:**

9.1.1 B – Lock✓
D – Fixed scale✓
E – Vernier scale✓ (3)

9.1.2 A – Inside measurement ✓
C – Depth measurement✓
F – Outside measurement✓ (3)

9.1.3 107,42 mm (Accuracy of the calliper is 0,02 mm)

(5)

9.2 16✓,72✓✓ mm✓ (4)

9.3 Flat✓ and V-way lathe beds✓ (2)

9.4 The four-jaw chuck is used to fit an irregularly shaped work piece on the centre lathe.✓✓ (2)

9.5 **Centre lathe components:**

9.5.1 The lead screw transmits feed motion for screw cutting.✓✓ (2)

9.5.2 The tailstock supports the right-hand side end of the work piece✓ and is also used in drilling, reaming and taper turning operations.✓ (2)

9.6 **Cutting tool angles:**

A – Side rake angle✓
B – Side relief angle✓
C – End relief angle✓
D – Back rake angle✓ (4)

9.7 **Reasons for using coolant when machining on the centre lathe:**

- It keeps the tool and work piece cool.✓
- Lubricates to reduce tool wear caused by friction.✓
- Prevents chip welding or the formation of an edge build-up✓
- Improves surface finish.✓
- It flushes away chips from the tool and machine bed.✓
- It prevents corrosion of the work piece and machine slides.✓
- It prevents inaccuracy due to expansion and heat.✓
- Higher cutting speeds and feeds can be achieved.✓
- Cutting tools will last longer.✓
- It reduces friction, meaning less power is required.✓

(Any 2 x 1) (2)

9.8 **Advantages of the compound slide method of taper turning:**

- Taper with large included angles can be turned✓
- Both internal and external tapers can be turned✓ (2)

9.9 **Disadvantages of the use of compound slide method of taper turning:**

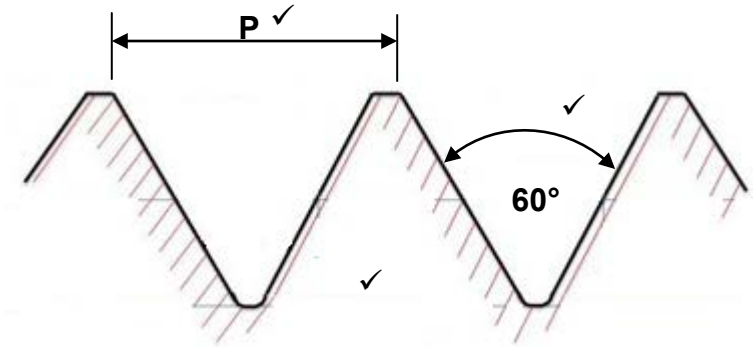
- Hand feed is necessary, but does give such a fine finish✓
- Only short tapers can be produced, as the length of the slide limits the length of the taper✓
- Monotony results in fatigue on the part of the operator✓

(Any 2 x 1) (2)
[33]

QUESTION 10: SYSTEMS AND CONTROL (SPECIFIC)

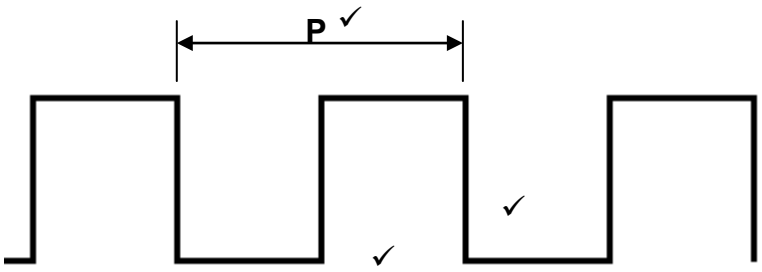
10.1 **Screw thread profiles:**

10.1.1 Metric V-screw thread (fine):



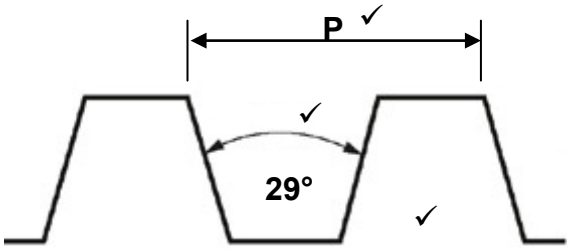
(3)

10.1.2 Square screw thread:



(3)

10.1.3 Acme screw thread:



(3)

10.2 **Screw threads:**

10.2.1 **Metric V-screw thread (fine):**

- Used where extra core strength is required✓
- Used where metal thickness affects the depth of thread✓
- Used where material thickness affects pitch✓

(Any 2 x 1) (1)

10.2.2 **Square screw thread:**

- Used where quick movement of a nut is required✓
- Used where accurate adjustment must be made, e.g. cross-slide of lathe✓
- Used where strength and force are required, e.g. bench vice and jacks✓

(Any 1 x 1) (1)

10.3 **Number of teeth:**

$$N_A \times T_A = N_B \times T_B \quad ✓$$

$$T_B = \frac{N_A \times T_A}{N_B} \quad ✓$$

$$T_B = \frac{120 \times 60}{70} \quad ✓$$

$$= 120 \text{teeth} \quad ✓$$

(4)

10.4 **Pulley calculations:**

$$V = \pi DN \quad \checkmark$$

$$V = \pi \times 0{,}460 \times \frac{180}{60} \quad \checkmark\checkmark$$

$$V = 4{,}34 \text{ m/s} \quad \checkmark$$

(4)

10.5 **Advantages of V belts:**

- May be used where the pulleys are very near to each other.✓
- When a V belt is broken, the machine may still run on the remaining belts, but will be overloaded.✓
- V belts may be ordered in any desired length, ready for immediate replacement.✓
- V belts need very little attention.✓
- A number of V belts running on a multi-grooved pulley may be used for heavy duty work.✓
- V belts are silent-running.✓

(Any 2 x 1) (2)

10.6 **Disadvantages of flat belts:**

- Flat belts are unsuitable for very short drives.✓
- When a flat belt breaks, the machine must be stopped while the belt is being repaired.✓
- Wide flat belts have to be used for heavy duty work, which leads to heavy belts.✓
- Flat belts are only available in long lengths which have to be fitted to each machine.✓
- Flat belts with fasteners and a 'belt slap' tend to be noisy.✓
- Flat belts must be cleaned and dressed regularly to prevent slipping.✓

(Any 2 x 1) (2)

10.7 **Advantages of gear drives:**

- May be used to obtain positive drive.✓
- Gear drives do not slip.✓
- Can drive in any direction.✓
- Varying rotational speeds may be obtained.✓
- Gear drives may be used where the direction of power transmitted must be changed.✓
- Gear drives are used where there is limited space.✓

(Any 2 x 1) (2)

10.8 **Disadvantages of chain drives:**

- Chain drives are not as flexible as belt drives.✓
- Chain drives are noisy.✓
- Chain drives require frequent adjustment compared to gear drives.✓
- Chain drives are more expensive than belt drives.✓

(Any 2 x 1) (2)

[27]

TOTAL SECTION B: 60

SECTION C: AUTOMOTIVE (SPECIFIC)

QUESTION 11: TERMINOLOGY (SPECIFIC)

11.1 **Name two types of friction clutches:**

- Single-plate clutch ✓
- Multiplate clutches ✓ (2)

11.2 **Adjustments to the hydraulically operated clutch unit:**

- An adjustment is made to the clutch pedal to prevent a build-up of pressure in the hydraulic system when the pedal is disengaged.✓ This prevents the release bearing from coming into contact with the pressure plate.✓ (2)

11.3 **Types of pressure plates:**

- Diaphragm type✓
- Helical spring type✓ (2)

11.4 **Clearance between a pressure plate and a thrust bearing (release bearing:**

- There must always be bearing clearance. If there is no operating clearance the bearing is in constant contact with the diaphragm and the bearing itself. This causes excessive diaphragm and bearing wear and causes the clutch plate to not be fully engaged. Clutch slippage or release problems will occur.✓ (1)

11.5 **Single-plate clutch assembly:**
Labels:

A. Pressure plate✓
B. Clutch plate✓
C. Flywheel✓ (3)

11.6 **Causes of clutch faults:**

11.6.1 **Clutch slip:**

- No clutch free play (insufficient clearance between the release bearing and the clutch fingers)✓
- Weak or broken pressure plate springs or diaphragm✓
- Excessive oil or water on friction surfaces✓
- Worn clutch plate linings✓
- Pressure in hydraulic system not relieved✓
- Pressure plate does not return to normal engaged position✓

(Any 1 x 1) (1)

11.6.2 **Clutch shuddering:**

- Lubricant on the plate linings (sliding friction between the plates cannot be achieved)✓
- Broken springs✓
- Burnt linings✓
- Cracked friction surfaces on the flywheel or pressure plate✓
- Broken or loose engine mountings✓

(Any1 x 1) (1)

11.7 **Functions of joints:**

11.7.1 **Slip joint:**

- Slip joints achieve variation of the driveshaft length.✓ (1)

11.7.2 **Universal joint:**

- Universal joints act as a link between two drive shafts which are not in line with each other in order to transmit toque at an angle.✓ (1)

11.8 **Types of gears:**

- Straight or spur teeth✓
- Helical gear teeth✓ (2)

11.9 **Constant-mesh gearbox:**

11.9.1 **The synchroniser unit:**

- To bring two gears to the same rotational frequency before they are engaged.✓✓ (2)

11.9.2 **Selector mechanism:**

- To transfer movement from the driver to the sliding gears or synchroniser units to obtain the required gear ratio.✓✓ (2)

[20]

QUESTION 12: MAINTENANCE (SPECIFIC)

12.1 **Pressure feed system and full pressure feed system:**

- In a pressure feed system, oil is distributed via the main oil channel to the main and camshaft bearings.✓ While in force feed, the piston rod pin of an engine, including the big end of the connecting rod, is pressure-lubricated.✓ (2)

12.2 **Crankcase ventilation system:**

- A breathing system that ensures that harmful gases in the crankcase are removed✓ (1)

12.3 **Oil consumption:**

- Oil consumption due to leakage✓
- Oil consumption due to burning✓
- Oil consumption due to evaporation✓

(Any 1 x 1) (1)

12.4 **Engine overheating:**

- Rust and lime deposits in the radiator tubes✓
- A thermostat stuck in the closed position✓
- A leaking radiator cap✓
- Water leakage in the system✓
- Freezing water in the radiator✓

(Any 1 x 1) (1)

12.5 **Crankcase gases:**

- Heat from the combustion process✓
- The heated oil being activated✓
- Petrol vapour that may be present✓
- Exhaust gases escaping past the piston rings✓

(Any 1 x 1) (1)

12.6 **Direct and indirect air cooling systems:**

- **Direct:** Uses air to cool the engine.✓
- **Indirect:** Uses air to cool the radiator water, which in turn cools the engine.✓ (2)

12.7 **Thermostat:**

- Prevents water from circulating through the radiator before the engine has reached working temperature.✓
- It maintains normal engine working temperature in very cold weather conditions.✓

(Any 1 x 1) (1)

12.8 **Oil dilution:**

- Oil is diluted when unburned fuel enters the crankcase and mixes with oil.✓ (1)

[10]

QUESTION 13: SYSTEMS AND CONTROL (SPECIFIC)

13.1 **Carburettor:**
- Changes the fuel from a liquid to a gas✓
- Measures fuel✓
- Controls engine speed✓

(Any 1 x 1) (1)

13.2 **Choke:**
- Provides a rich fuel mixture for quick starting when engine is cold.✓✓ (2)

13.3 **Air filtering systems:**
- Dry type✓
- Oil-bath type✓ (2)

13.4 **Brake fluid:**
- The fluid is incompressible✓
- The fluid transmits movement✓
- The fluid transmits force✓
- The fluid increases or decreases force✓

(Any 2 x 1) (2)

13.5 **Operation of the hydraulic brake wheel cylinder:**
- Brake fluid from master cylinder flows into the wheel cylinder via the inlet port.✓
- Hydraulic pressure forces the rubber seal outwards.✓
- The pushrod brings the brake shoe into contact with the brake drum.✓
- The spiral ensures that the rubber seal is always in contact with the piston, even in rest.✓ (4)

13.6 **Ohm's law:**
- Ohm's law states that 1 volt is required to induce a current flow of 1 ampere through resistance of 1 ohm.✓ (1)

13.7 **Electric current** is the movement of a number of electrons through a conductor.✓ (1)

13.8 **Electrical units:**

13.8.1 **Volt:** Potential difference✓ (1)

13.8.2 **Ampere:** Electric current✓ (1)

13.8.3 **Ohm:** Resistance✓ (1)

13.9 **Battery:**
- A battery is an electrochemical generator that converts chemical energy into electrical energy and vice versa.✓ (1)

[17]

QUESTION 14: ENGINES (SPECIFIC)

14.1 **Engine component:**

- Cylinder block✓ (1)

14.2 **Crankshaft and connecting rod:**

- The crankshaft and connecting rod convert the reciprocating/ linear movement✓ of the piston into a rotary motion✓ (2)

14.3 **Piston assembly:**

Labels

A. Piston rings✓
B. Piston head✓
C. Connecting rod✓
D. Big-end bearing✓ (4)

14.4 **Engine positioning advantages:**

14.4.1 **Front engine; front-wheel drive:**

- A long driving shaft is not required.✓
- Drive goes directly from gearbox and differential to the front wheels.✓
- The floor is lower and flatter because a driving shaft is not required.✓
- Road-handling ability, especially on wet, slippery roads, is improved because drive is directly in the direction in which steering takes place.✓
- The control cables and rods of the clutch, accelerator and gearbox control are short and simple.✓
- There are no problems with the cooling of the engine because the radiator may be mounted directly in the air flow, right in front of the vehicle.✓

(Any 1 x 1) (1)

14.4.2 **Front engine; rear-wheel drive:**

- Simple construction.✓
- The differential and gearbox can be serviced without removing the engine.✓
- The radiator can be positioned in the direct air current.✓
- Control rods and cables of the clutch, accelerator and gear change are short.✓

(Any 1 x 1) (1)

14.4.3 **Rear engine; rear wheel-drive:**

- The exhaust system is short.✓
- The engine mass is positioned directly above the drive wheels.✓
- When the brakes are applied, the centre of gravity is transferred to the centre of the vehicle, which means that the braking ability of all the wheels can be put to full use.✓

(Any 1 x 1) (1)

14.5 **Engine positioning disadvantages:**

14.5.1 **Front engine; front-wheel drive:**

- Intricate and expensive constant velocity joints have to be used because drive and steering occurs by means of the front wheels.✓
- The repair and servicing of some components are difficult since the power source and drive train are installed in a compact space.✓

(Any 1 x 1) (1)

14.5.2 **Front engine; rear-wheel drive:**

- A long drive shaft must be used. This necessitates a drive shaft tunnel or bulge in the floor pan.✓
- A long exhaust system with many bends and twists has to be used.✓

(Any 1 x 1) (1)

14.5.3 **Rear engine; rear-wheel drive:**

- Because the engine is not positioned in a direct air current, a large fan must be used to cool the engine.✓
- The engine is exposed to dust.✓
- The mass distribution on the front wheels is poor.✓
- The control cables and rods for the clutch, accelerator and gear shift are very long.✓

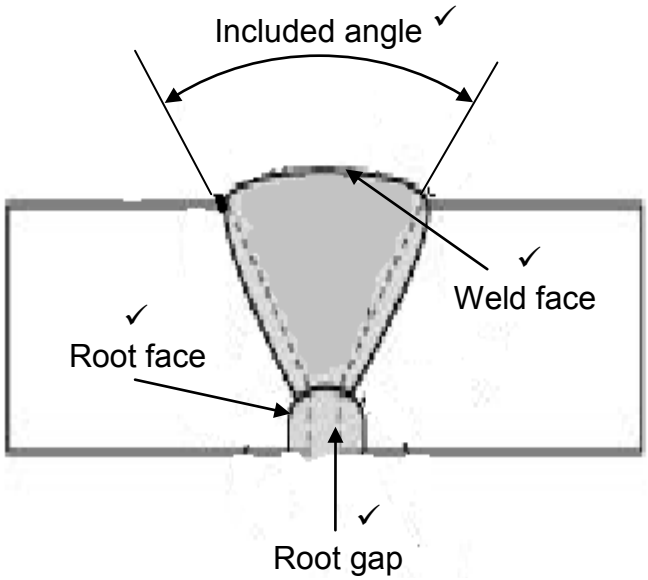
(Any1 x 1) (1)
[13]

TOTAL SECTION C: 60

SECTION D: WELDING AND METALWORK (SPECIFIC)

QUESTION 15: WELDING TERMINOLOGY (SPECIFIC)

15.1 **Welding terminology:**



(4)

15.2 **Template materials:**

- Cardboard✓
- Wood✓
- Hardboard✓
- Steel✓

(Any 2 x 1) (2)

15.3 **Pythagoras:**

$$R^2 = BC^2 + AC^2 \quad ✓$$
$$R^2 = 40^2 + 30^2 \quad ✓$$
$$R^2 = 1600 + 900 \quad ✓$$
$$R = \sqrt{2500}$$
$$R = 50\,\text{mm} \quad ✓$$

(4)
[10]

QUESTION 16: ARC WELDING (SPECIFIC)

16.1 **Arc welding operation:**

- In electric arc welding the source of heat to melt the metal✓ comes from an electric arc with a high current flow (ampere) at a low to moderate voltage✓ between the work piece and the electrode✓. (3)

16.2 **Welding accessories:**

16.2.1 **Electrode holder:**

- Holds the electrode to complete the circuit ✓ (1)

16.2.2 **Earth clamp:**

- Clamps the earth cable to the metal work piece to complete the circuit.✓ (1)

16.2.3 **Transformer:**

- Converts the normal power input to a high amperage output current at a much lower voltage.✓ (1)

16.3 **Welding machines:**

16.3.1 **Direct current (DC):**

- Two-thirds of the heat is developed at the positive side and one third at the negative side. The work piece is usually connected to the positive side of the supply current and the electrode is attached to the negative side. If the work piece is made negative and the electrode positive, it is referred to as reverse polarity.✓✓ (2)

16.3.2 **Alternating current (AC):**

- The direction of flow of an alternating current constantly reverses at a rate of many times per second. It means that current flows for one-hundredth of a second in one direction, and then for the following one hundredth of a second in the opposite direction. For this reason the amount of heat developed on the base metal is equal to the heat developed at the end of the electrode.✓✓ (2)

[10]

QUESTION 17: GAS WELDING (SPECIFIC)

17.1 **Oxy-acetylene torches:**

- Welding torch✓
- Cutting torch✓ (2)

17.2 **Purpose of welding components:**

17.2.1 **Regulator:**

- To reduce the high pressure of gas in the cylinder to an operating pressure suitable for welding.✓
- It keeps the operating pressure constant regardless of the pressure in the cylinder.✓

(Any 1 x 1) (1)

17.2.2 **Flashback arrestor:**

- To protect the operator and equipment against the hazard of mixed-gas explosions.✓ (1)

17.2.3 **Torch:**

- To mix the gases✓
- To accommodate the nozzles✓

(Any 1 x 1) (1)

17.3 **Colour codes:**

17.3.1 **Acetylene cylinders**

- Red/Maroon✓ (1)

17.3.2 **Oxygen cylinders**

- Black✓ (1)

17.4 **Oxy-acetylene flames:**

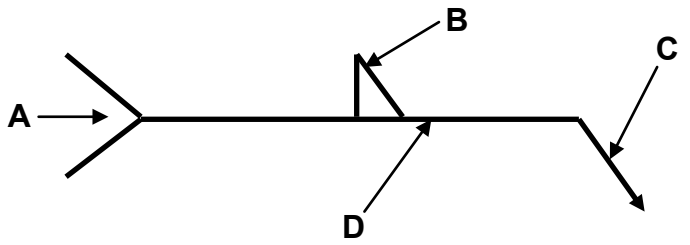
17.4.1 **Oxidising flame**
Used for cutting purposes✓ (1)

17.4.2 **Carburising flame**
Used for heating purposes✓ (1)

17.4.3 **Neutral flame**
Used for welding purposes✓ (1)
[10]

QUESTION 18: WELDING SYMBOLS AND JOINTS (SPECIFIC)

18.1 **Welding symbol**



tail (A)✓; weld symbol (B)✓; arrow (C)✓; reference line (D)✓ (4)

18.2 **Welding symbols**

18.2.1 **Double U butt joint:**

✓ (1)

18.2.3 **J butt joint:**

✓ (1)

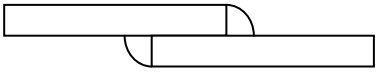
18.2.2 **V butt joint:**

✓ (1)

18.3 **Welded joints:**

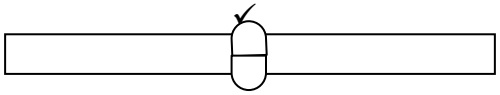
18.3.1 **Lap joint:**

✓



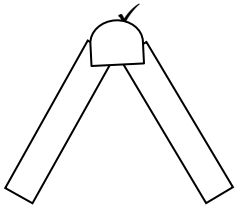
✓ (2)

18.3.2 **Butt joint:**



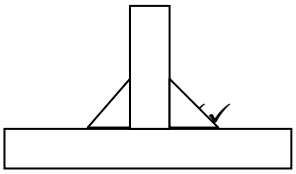
✓ ✓ (2)

18.3.3 **Edge joint:**



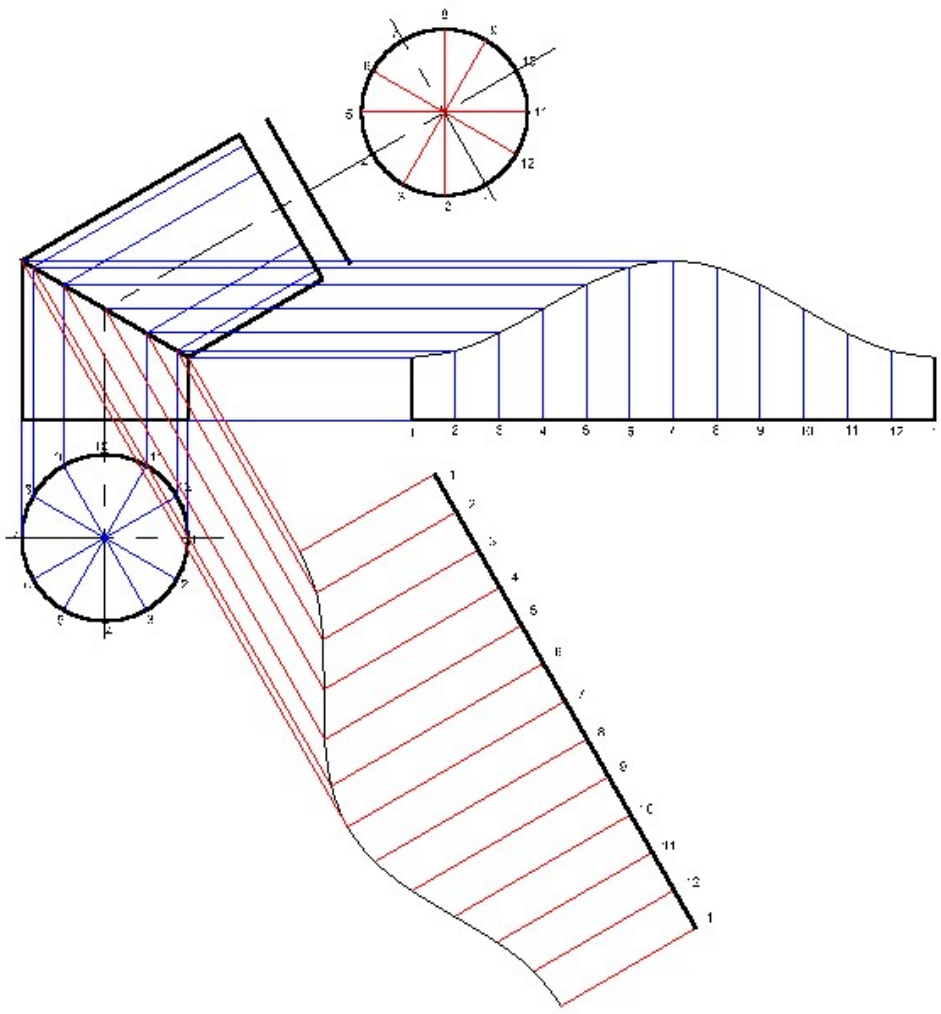
✓ (2)

18.3.4 **Fillet joint:**



(2)
[15]

QUESTION 19: DEVELOPMENT (SPECIFIC)



3 marks for division of circle
12 marks for development **[15]**

TOTAL SECTION D: 60
GRAND TOTAL: 200