



Regional
NSW

CANDIDATE NUMBER: _____ **(write in from your letter)**

EXAMINATION: MECHANICAL ENGINEER

EXAM PAPER: CME 3 – Safety and mining legislation applicable to surface coal mines

DATE: Wednesday 9th August, 2023 – 1:10 pm to 3:50 pm

DURATION: 2.5 hours (excluding 10 minutes reading time)

EXAMINATION FOR CERTIFICATE OF COMPETENCE TO BE A MECHANICAL ENGINEER OF COAL MINES OTHER THAN UNDERGROUND COAL MINES

Issued under the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022*

INSTRUCTIONS TO CANDIDATES:

Unless otherwise stated all references to Act and Regulations are to the

Work Health and Safety Act 2011

Work Health and Safety Regulation 2017

Work Health and Safety (Mines and Petroleum Sites) Act 2013

Work Health and Safety (Mines and Petroleum Sites) Regulation 2022

Candidates shall be seated in the exam room no later than 1:00 pm for exam instructions.

10 minutes reading time is allowed prior to the start of the examination. Candidates can use a **highlighter only** to mark points of importance during the reading time, but may not begin answering the questions. You must NOT use any other writing item during the reading time such as a pen.

After reading time is over place your identification number only, **NOT** your name, on the cover of this paper at the commencement of the exam. Electronic aids may not be used, apart from a non-programmable calculator.

It is expected that candidates will present their answers in an engineering manner, making full use of diagrams, tables, and schematics as appropriate, and showing full workings in calculations. **Poor legibility in diagrams and handwriting** may affect the candidate being deemed competent.

Provide answers in point form wherever appropriate. If you are unable to fit your answers in the available space use the three (3) blank pages included at the end of the paper. Ensure the question you are answering is clearly marked.

All ten (10) questions are to be attempted. All questions are of equal value.

Candidates will be marked, and determined as competent, or not yet competent. If a question is identified as **ESSENTIAL** then then the candidate must be deemed competent in that question in order to be deemed competent in the exam. If a part of a question is identified as **ESSENTIAL** then the candidate must be deemed competent in that part in order to be deemed competent in that question and the marks for that question to be counted.

This examination is a **closed book** examination and no reference material may be used during the exam. Reference material will be provided in the exam paper as applicable.

EXAMINATION BOOKLET

Question Number		Essential	Competent / not yet competent	Mark	Assessed by <i>Name</i>	Comments to justify, as necessary
1	A	Essential				
	B	Essential				
	total			/ 25		
2	A					
	B					
	C					
	total			/ 25		
3	A					
	B	Essential				
	C					
	total			/ 25		
4	A					
	B					
	C					
	D					
	E					
	total			/ 25		
5	A					
	B					
	C					
	D					
	E					
	total			/ 25		

Question Number	Essential	Competent / not yet competent	Mark	Assessed by <i>Name</i>	Comments to justify, as necessary
6	A				
	B				
	C				
	D				
	E				
	F				
	total			/ 25	
7	A				
	B				
	C				
	D				
	E				
	F				
	total			/ 25	
8	A				
	B				
	C				
	D				
	total			/ 25	
9	A				
	B				
	total			/ 25	
10	A				
	B				
	C				
	total			/ 25	

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Question Number		Essential	Competent / not yet competent	Mark	Assessed by <i>Name</i>	Comments to justify, as necessary
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PAPER	Verdict		TOTAL	/ 250		<i>Marks checked by:</i>
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If marking is reviewed under approved processes, then examiner is to record details:

Date	Examiner	Questions reviewed	Marks changed	Details/justification, as necessary
Eg. 2/8/19	Andrew Palmer	All	Q1 – 4 (previously 5)	Found one more criteria

Legislation

Question 1 – Role of Mechanical Engineer and MECP

Essential

The candidate must be assessed as competent for this question in order to be considered as being competent for the entire exam

The role of the Mechanical Engineer

Work Health and Safety (Mines and Petroleum Sites) Regulation

Schedule 10 Part 2 Underground coal mines

21 Mechanical engineer

(1) The statutory functions of mechanical engineer are—

- (a) to develop and review the standards, mechanical engineering practice and procedures for the life cycle of mechanical plant and installations at the mine, and
- (b) to supervise the _____, _____, _____, and _____ of mechanical plant at the mine.

A. What are the four (4) requirements in relation to Section 1) b above?

4 marks

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B. Schedule 2 (2) (3) below identifies matters that must be taken into account when developing control measures for mechanical hazards. Fill in the missing words as they are identified in legislation.

21 marks

Work Health and Safety (Mines and Petroleum Sites) Regulation

Schedule 2 Principal Control Plans

(2) Mechanical engineering control plan

(3) The following matters must be taken into account when developing a control measure referred to in subsection (2)—

- (a) the _____ and operation of plant or a structure to ensure it is fit for purpose,

- (b) the _____, _____, _____, _____, _____, _____, and _____ of plant or structures,
- (c) the _____ of plant or structures into the mine or petroleum site,
- (d) safe work systems for persons dealing with plant or structures including the _____, _____ and _____ of all mechanical energy sources from plant or structures,
- (e) the inspection and testing of plant or structures including testing of _____, _____, _____ and other _____ functions or components,
- (f) the identification, assessment, management and rectification of _____ that affect the safety of plant or structures,
- (g) the risks associated with _____, including _____,
- (h) for underground coal mines—the arrangements for meeting and maintaining requirements for registration under this Regulation, section 187 and the WHS Regulations, Part 5.3 in relation to plant with a diesel engine,
- (i) the risks associated with plant, including face machines, winding systems, mobile plant, drilling plant and dredges,
- (j) the risks associated with _____,
- (k) the risks associated with the transfer and storage of combustible liquids and other hazardous or volatile material associated with the use of plant or structures,
- (l) the prevention, detection and suppression of fires on mobile plant and conveyors,
- (m) the provision of operator protective devices on mobile plant including protective canopies on continuous miners when controlled by an on-board operator,
- (n) the maintenance of explosion-protected plant in an explosion-protected state,
- (o) undertaking _____,
- (p) the use of _____ and materials in high risk underground applications.

Question 2 – Mechanical engineering control plan

Part of the role of the Mechanical Engineer is to set up and maintain a logical hierarchy of systems and documents to manage mechanical risks at the mine.

- A. List six (6) key personnel you would include in the preparation and/or review of the MECP risk assessment. 6 marks

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- B. List nine (9) Standards of Engineering Practice (SEP) that you would include as subordinate documents to your MECP. 9 marks

	/ 9
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Question 4 – Contractor management

Work Health and Safety (Mines and Petroleum Sites) Regulation

Section 26 Contractor to prepare plan or use safety management system

(1) A contractor must not carry out mining operations or petroleum operations at a mine or petroleum site unless the contractor has—

As the statutory Mechanical Engineer at your mine site, you are required to onboard a new contracting company that will conduct contract mining, provide some small mining equipment, and carry out maintenance to this equipment.

A. Having regard to Section 26 (1) outline four (4) requirements the contract company must comply with to manage the risks to health and safety. 5 marks

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(2) Subsection (1) does not apply if the contractor has—

B. Section 26 (2) allows for an alternative approach for the contractor to manage risks to health and safety. Having regard to 26 (2) outline three (3) key steps you consider would constitute an alternative approach that provides equivalent levels of risk management. 3 marks

	/ 3
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(3) A contractor health and safety management plan must—

C. When considering Section 26 (3) what are four (4) key requirements to manage the risks to health and safety to be contained in the contract company’s contractor health and safety management plan? 6 marks

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As the statutory Mechanical Engineer at the mine site, you are required to assist the contractor to compile a health and safety management plan.

D. Detail five (5) key steps you would take to ensure the development of a contractor health & safety management plan is undertaken successfully. 5 marks

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Question 5 – Falls

Work Health and Safety Regulation

Clause 78 Management of risk of fall

(1) A person conducting a business or undertaking at a workplace must manage, in accordance with Part 3.1, risks to health and safety associated with a fall by a person from one level to another that is reasonably likely to cause injury to the person or any other person.

A. Clause 78 (2) identifies five general scenarios where falls could occur in the workplace. In practical terms describe three (3) of these different types of fall scenarios that could occur in your workplace. 6 marks

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(3) A person conducting a business or undertaking must ensure, so far as is reasonably practicable, that any work that involves the risk of a fall to which subclause (1) applies is carried out on the ground or on a solid construction.

B. Clause 78 (3) uses the term solid construction, and Clause 78 (5) describes four (4) aspects that an area of solid construction must have. In practical terms identify three (3) parameters required for an area to be considered solid construction. 6 marks

	/ 6
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Clause 79 Specific requirements to minimise risk of fall

(3) The person provides adequate protection against the risk if the person provides and maintains a safe system of work, including by:

- (a) providing a fall prevention device if it is reasonably practicable to do so, or
- (b) if it is not reasonably practicable to provide a fall prevention device, providing a work positioning system, or
- (c) if it is not reasonably practicable to comply with either paragraph (a) or (b), providing a fall arrest system, so far as is reasonably practicable.

C. Clause 79 (3) (a) refers to fall prevention devices. In practical terms describe three (3) different types of fall prevention devices that you would implement in your workplace. You may include those referenced in Clause 79 (5). 6 marks

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D. What is the Australian Standard for fixed platforms, walkways, stairways, ladders – design, construction, and installation? 2 marks

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E. What are the following minimum dimensions in the standard identified above that are required for platforms? 5 marks

Hand rail height	
Knee rail height	
Toe board / kick rail height	
Width of walking surface	
Distance between hand rail and knee rail	

	/ 5
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Mechanical Practices

Question 6 – Conveyors

Conveyor drive heads have many different configurations, each with advantages and disadvantages

- A. List three (3) mechanical impacts to the operation of the conveyor drive when the drive pulley diameter is increased. 3 marks

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- B. What are three (3) mechanical benefits of increasing the drive pulley lagging coefficient of friction? 3 marks

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- C. What effect does LTU tension have on drive power? 3 marks

	/ 3
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D. Draw a symbolic picture of a clean side - clean side drive that also utilizes two snub pulleys, and indicate the location of the jib pulley, drive pulleys, snub pulleys, belt reeving, belt wander switches, belt direction of travel, and the top cover of the belt. 8 marks

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E. List five (5) monitoring items you would incorporate in your conveyor drive head, not including belt wander switches. 5 marks

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F. List three (3) automated methods that could be used to protect the conveyor in the event of a drive head fire. 3 marks

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Question 7 – Safety Bulletin – Lifting and crange

Safety Bulletin SB22-14 dated December, 2022, was released in response to a significant increase in injuries and near misses relating to lifting and crange.



December 2022

Dangerous lifting equipment incidents increase

This safety alert provides safety advice for the NSW mining industry.

Issue

A significant rise in the number of dangerous incidents involving lifting equipment has prompted the NSW Resources Regulator to review recent events in the NSW mining industry.

Within a one-month period between mid-October and mid-November, 2022, there were 7 lifting-related dangerous incidents, with 4 of these occurring over 5 days. The incidents involved cranes, chain/lever hoists and self-propelled jigs, with a range of causes and contributing factors.

Circumstances

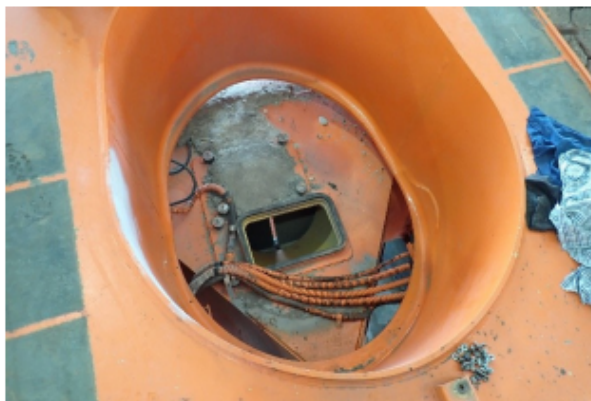
1. Dangerous incident – 13 November (Figure 1)

A work group at an open cut coal mine was installing a 2.7 tonne motor and gearbox assembly at the top of a reclaimer. The assembly was being lifted in with a slew crane when the job coordinator, not part of the work group, approached the task. The coordinator observed the load swinging around and instinctively reached out and grabbed the load. The coordinator's left hand index finger was caught between the load and the structure of the reclaimer, partially amputating the finger.

Figure 1: Reclaimer motor and gearbox



Figure 2: Haul truck rear axle box hole



The investigations associated with these incidents identified a range of causes and contributing factors, however, there were several common themes, including the following:

- The lack of experience of workers and supervisors affected the identification of hazards. Workers can't identify what they don't know
- The lack of implementing appropriate controls to protect workers
- Operational and maintenance documentation did not match equipment
- A lack of risk assessment, job safety analysis, or procedure being developed

D. What is your definition of a complex lift?

3 marks

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E. What is your understanding of the term 'swing zone'?

3 marks

	/ 3
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F. What controls would you implement to manage complex lifts?

5 marks

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Question 8 – Haul truck front suspension strut

You are the statutory Mechanical Engineer at a mine that includes operating a small fleet of haul trucks. Your workshop maintenance coordinator has identified that two of the haul trucks require the front suspension struts replaced. Recently there have been three serious incidents relating to the replacement of front suspension struts on haul trucks where trades persons involved in the removal of the struts were placed at risk.

A. Identify five (5) hazards directly associated with the removal and installation of front struts.

5 marks

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B. For the collective hazards identified above describe six (6) control measures you would implement to minimise the potential for injuries to workers involved in the task of repairing or replacing front suspension struts.

12 marks

	/ 12
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C. For the control measures identified above describe three (3) control verification measures that you will include in your inspection and testing scheme. 3 marks

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D. When considering your workforce, contractors, and OEM trades persons, identify five (5) training elements you would introduce to ensure the safe replacement of front struts. 5 marks

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Question 9 – Mechanical fundamentals

A. What are the approximate conversions for the following measured units

5 marks

Measurement / Unit	Target unit	Converted measurement
100 psi	kPa	
1 inch	Mm	
1 thou	Mm	
1 ft lb force	Nm	
100 kPa	Bar	

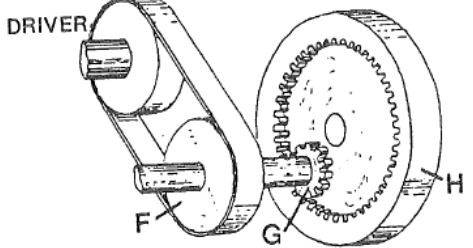
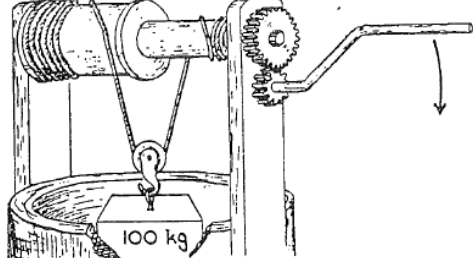
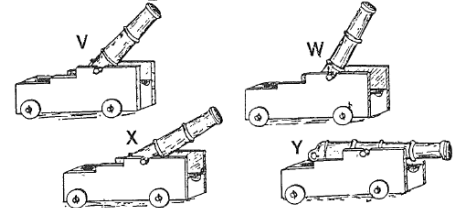
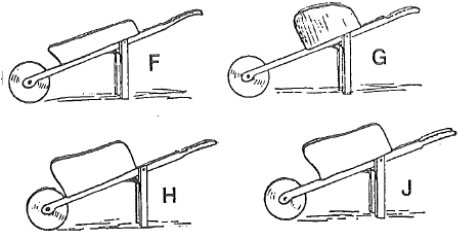
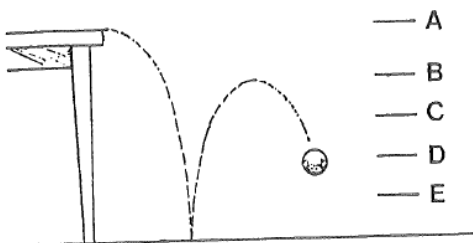
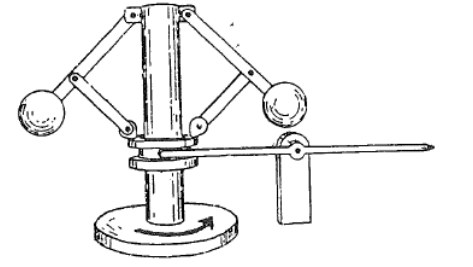
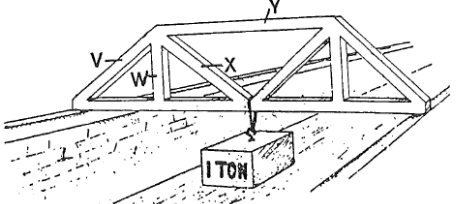
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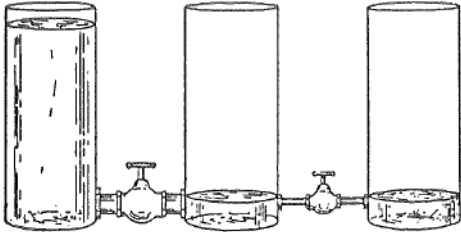
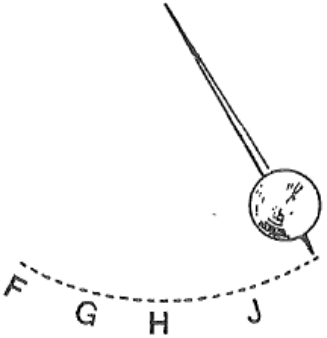
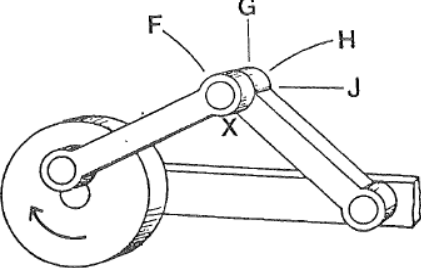
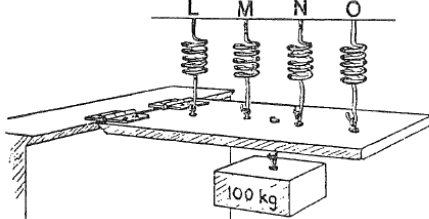
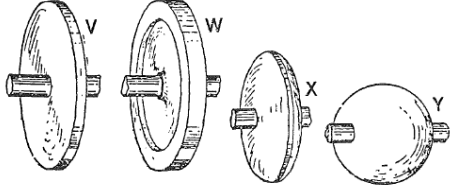
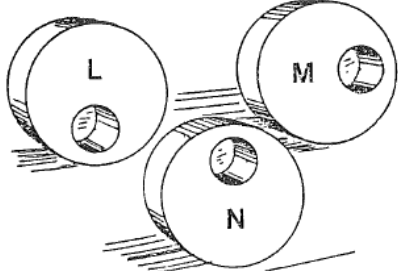
B. Interpretation of mechanical systems:

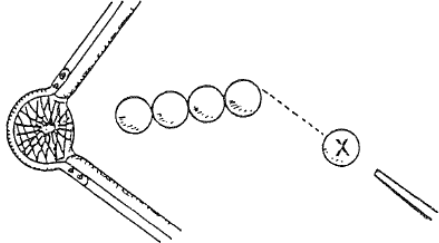
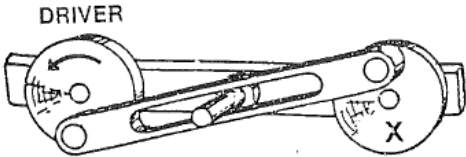
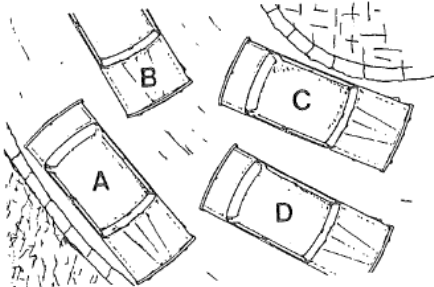
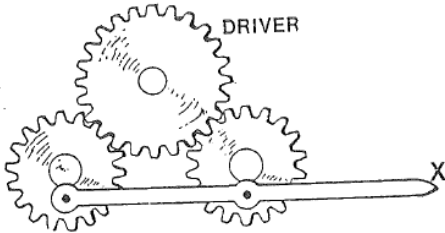
20 marks

Circle the most correct answer, or write your answer in the answer column on the right.

No.	Scenario	Question	Ans
1		Which of these tent pegs will hold firmest in soft ground? a) F b) G c) H d) J e) All equal	
2		Which part of the rope is carrying the greatest strain? a) V b) W c) X d) Y e) All equal	
3		What happens to position X on the rod when the wheel turns? a) Moves right then stops b) Stays still c) Moves to and fro d) Continues to move left e) The mechanism will jam	

4	 <p>DRIVER</p> <p>F, G, H</p>	<p>Which of these components rotate in the same direction as the driver?</p> <ol style="list-style-type: none"> F and G only G and H only H only All of them None of them 	
5	 <p>100 kg</p>	<p>What will happen to the weight when the handle is turned as shown?</p> <ol style="list-style-type: none"> Rise Fall Stay still Move up and down The mechanism will jam 	
6	 <p>V, W, X, Y</p>	<p>Which cannon will shoot the furthest?</p> <ol style="list-style-type: none"> V W X Y All equal 	
7	 <p>F, G, H, J</p>	<p>On level ground in which wheelbarrow can a person carry 100kg of sand the easiest?</p> <ol style="list-style-type: none"> F G H J All equal 	
8	 <p>A, B, C, D, E</p>	<p>To what height will the ball rise on the next bounce?</p> <ol style="list-style-type: none"> A B C D E 	
9		<p>What will happen to the tip of the pointer when the wheel spins faster in the direction shown?</p> <ol style="list-style-type: none"> Rise Fall Move up and down Stay still The mechanism will jam 	
10	 <p>V, W, X, Y</p> <p>1 TON</p>	<p>Which member of the bridge truss is carrying the least strain?</p> <ol style="list-style-type: none"> V W X Y All equal 	

11		<p>What will happen to the water level in tank X when both taps are turned fully on?</p> <ol style="list-style-type: none"> Rise until tank overflows Rise and then fall Fall until the tank empties Fall and then rise Rise slowly 	
12		<p>After the pendulum is released at which point is the tip moving fastest?</p> <ol style="list-style-type: none"> F G H J All equal 	
13		<p>Which of these paths would joint X follow when the wheel turns as shown?</p> <ol style="list-style-type: none"> F G H J None of the paths shown 	
14		<p>Which spring is carrying the greatest weight?</p> <ol style="list-style-type: none"> L M N O All equal 	
15		<p>Which of these 100kg flywheels when spinning at the same speed would be the hardest to stop?</p> <ol style="list-style-type: none"> V W X Y All equal 	
16		<p>Which of these steel cylinders when pushed slightly would return to its present position?</p> <ol style="list-style-type: none"> L M N All of them None of them 	

17		<p>How many billiard balls will go into the pocket when ball X is hit very hard?</p> <ul style="list-style-type: none"> a) None b) One c) Two d) Three e) Four 	
18		<p>How will wheel X turn if the driver wheel turns as shown?</p> <ul style="list-style-type: none"> a) Same direction, same speed b) Same direction initially then oscillating c) Opposite direction, same speed d) Opposite direction then oscillating e) The mechanism will jam 	
19		<p>Four identical cars are racing and reach the corner at the same speed. Which car is most likely to skid?</p> <ul style="list-style-type: none"> a) A b) B c) C d) D e) All equal 	
20		<p>What will happen to the pointer marked X when the driver turns</p> <ul style="list-style-type: none"> a) Move up and down b) Move in a circle c) Move to and fro d) Stay still e) The mechanism will jam 	
With thanks to J.R Morrisby c1955			

Question 10 – Safety critical systems

You are the statutory Mechanical Engineer at a coal mine with a CHPP, rejects emplacement area, and a large legacy tailings dam. The CHPP Manager has been tasked with remediating the tailings dam, which will require accessing the moist but relatively firm surface of the tailings dam to recover old equipment prior to capping. For this work the nominated contract company will use a low track pressure excavator.



DATE: August 2022

Stranded worker rescued from active tailings dam.

This safety alert provides safety advice for the NSW mining industry.

Issue

A 14-tonne amphibious excavator became immobilised about 200 m offshore on an active tailings dam, leaving the operator stranded for 7 hours on 29 June 2022. The incident occurred at Ravensworth coal preparation plant, in the NSW Hunter Valley. The emergency procedure relied on an all-terrain vehicle (ATV) as the sole means of rescuing people from the dam but when needed to be used, the ATV could not be driven on the dam.

Circumstances

The excavator was immobilised after one of its tracks was damaged. The rescue plan for the excavator operator relied on the ATV, but the ATV could not gain traction across the tailings and was unable to travel far from the shore before having to return.

The excavator became immobilised at 3.30pm and at 10.16pm, a four-person rescue team entered the dam to rescue the operator, using ply boards and a rope tethered to the bank.

The rescue team, comprised of NSW Mines Rescue and Ravensworth mine members, had controls in place because of the potentially unstable surface of the dam.

At 10.33pm, the rescue team and excavator operator returned safely to the shore. The operator was uninjured.

Investigation

The investigation has identified:

1. The capability of the rescue vehicle was not tested before the amphibious excavator started work on the active tailings dam.
2. The risk assessment and rescue/emergency plan for the amphibious excavator task did not consider contingency plans beyond the use of the rescue vehicle.

3. An assessment of risks to the rescue team entering the active tailings dam occurred but did not include a geotechnical assessment of the tailings material.

Figure 1: Amphibious excavator stranded on the active tailings dam.



As a result of Safety Alert SA22-02 in August 2022, Stranded worker rescued from active tailings dam, the Contractor has elected not to use a quad bike or side by side as the rescue vehicle, and has proposed to use a three person petrol powered hovercraft for emergency recovery.



A. Who would you involve in identifying hazards, assessing risks, and nominating controls? 5 marks

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B. Identify ten (10) hazards you consider are directly associated with the operation and maintenance of hovercraft. 10 marks

	/ 10
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BLANK PAPER TO WRITE ANSWERS THAT YOU COULD FIT INTO THE SPACE PROVIDED – INDICATE QUESTION NUMBER AT START OF ANSWER

END OF PAPER