For Supervisor's use only

2

90255

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 2 Physics, 2004

90255 Demonstrate understanding of mechanics

Credits: Six
2.00 pm Thursday 18 November 2004

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

For all numerical answers, full working must be shown. The answer should be given with an SI unit.

For all 'describe' or 'explain' questions, the answer should be in complete sentences.

Formulae you may find useful are given on page 2.

If you need more space for any answer, use the pages provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–15 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

For Assessor's use only

Achievement Criteria		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Identify or describe aspects of phenomena, concepts or principles.	Give descriptions or explanations in terms of phenomena, concepts, principles and/or relationships.	Give concise explanations that show clear understanding, in terms of phenomena, concepts, principles and/or relationships.
Solve straightforward problems.	Solve problems.	Solve complex problems.
Overall Level of Performance (all criteria within a column are met)		

You are advised to spend 60 minutes answering the questions in this booklet

Assessor's use only

You may find the following formulae useful.

$$v = \frac{\Delta d}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad v_f = v_i + at$$

$$d = v_i t + \frac{1}{2}at^2 \qquad d = \frac{v_i + v_f}{2}t \qquad v_f^2 = v_i^2 + 2ad$$

$$a_c = \frac{v^2}{r}$$

$$F = ma \qquad \tau = Fd \qquad F = -kx$$

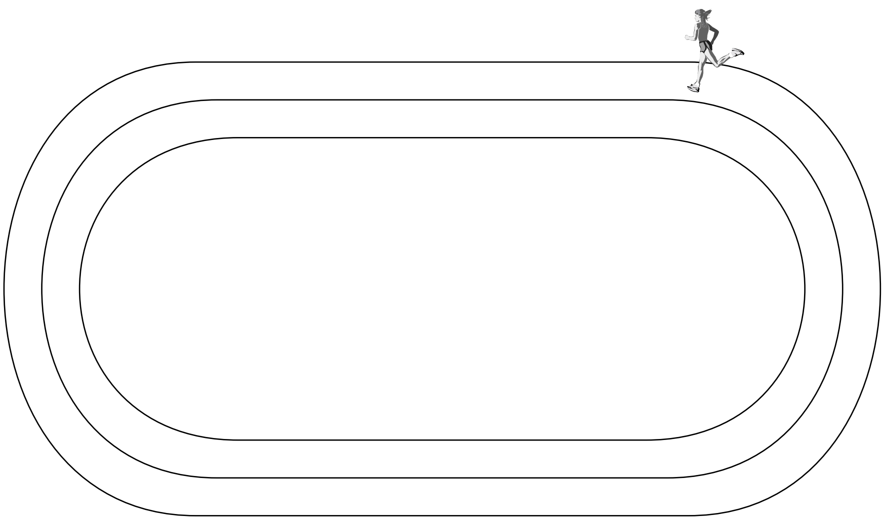
$$F_c = \frac{mv^2}{r} \qquad p = mv \qquad \Delta p = F\Delta t$$

$$E_p = \frac{1}{2}kx^2 \qquad E_k = \frac{1}{2}mv^2 \qquad \Delta E_p = mg\Delta h$$

$$W = Fd \qquad P = \frac{W}{t}$$

QUESTION ONE: SCHOOL SPORTS – RUNNING

Ana runs a 400 m race around the school track in 65 seconds.



(a) Calculate Ana's **average** speed for the race.

Average speed =

(b) At the **start** of the race, Ana accelerates to a speed of 6.0 ms^{-1} during the first 2.2 seconds. Calculate her acceleration, assuming it is constant.

Acceleration = ______________

(c) Calculate the distance that Ana travels during these first 2.2 seconds.

Distance = ______________

(d) During the middle part of the race, Ana, whose mass is 55 kg, is running at a steady speed of 6.5 m s^{-1}. Calculate her kinetic energy at this point in the race. State the **unit** for your answer.

Kinetic energy = ______________ ________ (unit)

(e) At the end of sports day, Ana drives home. During part of her journey, her car travels horizontally along a straight road for 40 m at a constant speed of 15 m s^{-1}. At this speed the car engine produces 6000 W of power. Calculate the size of the force needed to keep the car moving at this speed.

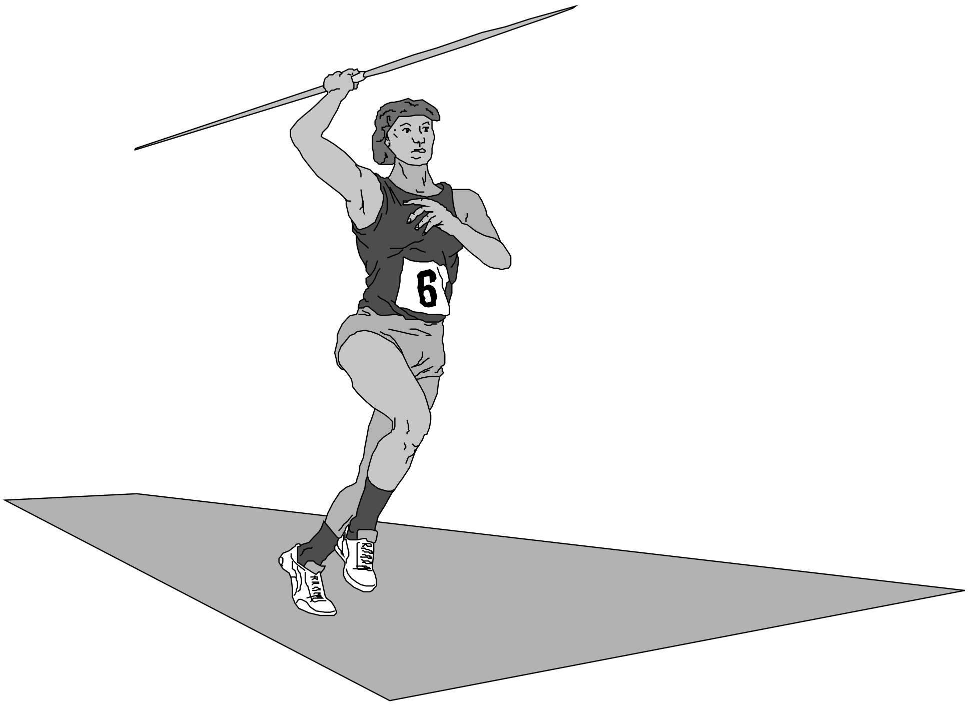
Force = ______________

Assessor's use only

QUESTION TWO: SCHOOL SPORTS – JAVELIN

Where needed, use $g = 10.0 \text{ m s}^{-2}$.

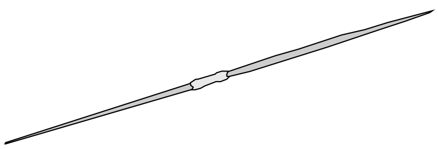
Joe is taking part in a javelin competition. The javelin behaves like a projectile.



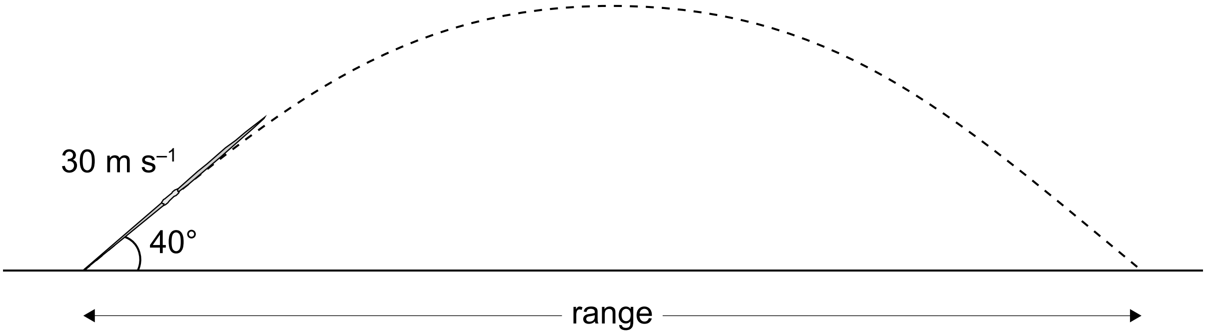
(a) Name the **shape** of the path of the javelin.

___

(b) Ignoring air resistance, draw arrow(s) on the drawing of the javelin below to show the force(s) acting on it when it is in the position shown. **Name** the forces.



Joe now throws the javelin into the air at an angle of 40° above the horizontal at an initial velocity of 30 m s^{-1}.



(c) **Show** that the **horizontal component** of the initial velocity of the javelin is 23 m s^{-1}.

(d) Calculate the **range** (horizontal distance travelled) of the javelin under these conditions.

Range = ______________

Assessor's use only

Assessor's use only

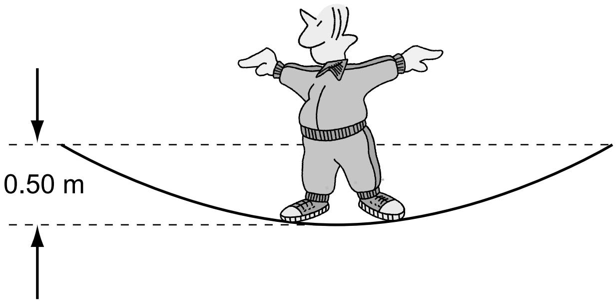
QUESTION THREE: SCHOOL GYM

Where needed, use $g = 10.0 \text{ m s}^{-2}$.

(a) **The Trampoline**

Henry is bouncing on the elastic mat of a trampoline.

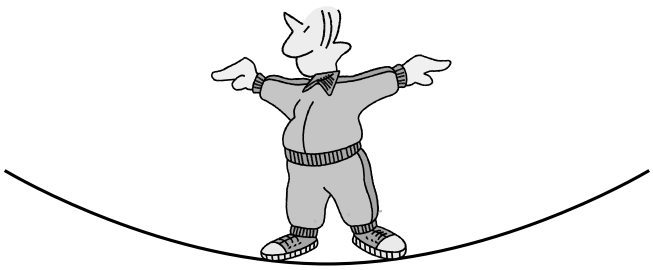
In order to gain the necessary height to perform a certain move, Henry has stretched the mat downwards by 0.50 m. The spring constant of the mat is 3500 N m^{-1}.



(i) Calculate the size of the force supplied by the mat when stretched by this amount.

Force = ______________________

(ii) On the diagram below, draw **labelled** arrow(s) to show the force(s) acting **on Henry** when he is at the lowest point of his bounce.



Assessor's use only

Henry has a mass of 75 kg.

(iii) Calculate the value of the **net** force acting on Henry when the trampoline mat is stretched downwards by 0.50 m.

Net force = ______

(iv) State the direction of this net force.

(v) Calculate Henry's initial acceleration when the mat is stretched downwards by 0.50 m.

Acceleration = ______

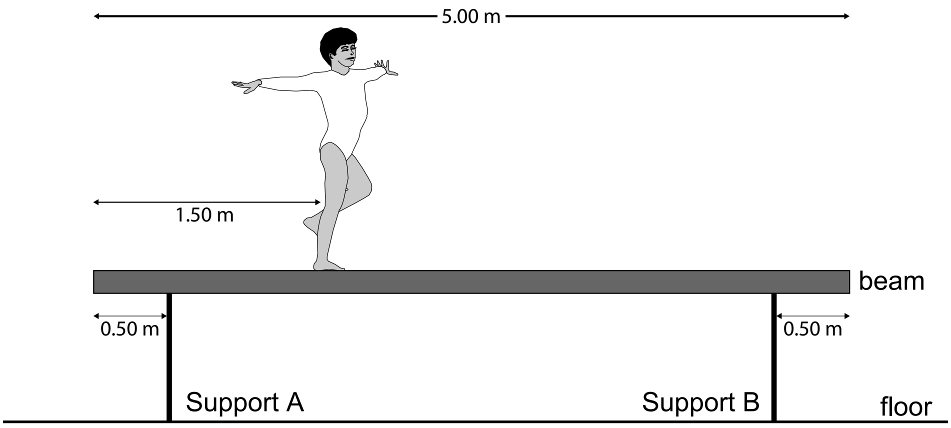
(vi) Calculate the vertical height to which Henry will rise above his lowest position.

Height = ______

(vii) Explain the physics involved in finding the answer to (vi), including a statement of any assumptions made.

(b) **The Balance Beam**

Nadia is performing an exercise on the balance beam. The beam is 5.00 m long and has two supports, A and B, each 0.50 m from either end. The beam is uniform and rigid and has a mass of 90 kg. Nadia's mass is 55 kg and she is standing 1.50 m from the left hand end as shown below.



(i) On the diagram, draw four **labelled** arrows in the correct **positions** and pointing in the correct **directions** to show each of the following forces

(1) Nadia's weight

(2) The weight of the beam

(3) The support force provided by support A

(4) The support force provided by support B

(ii) State the value of

(1) Nadia's weight

(2) The weight of the beam

(1)

(2)

(iii) Calculate the value of the support force at A when Nadia is in the position shown.

Assessor's use only

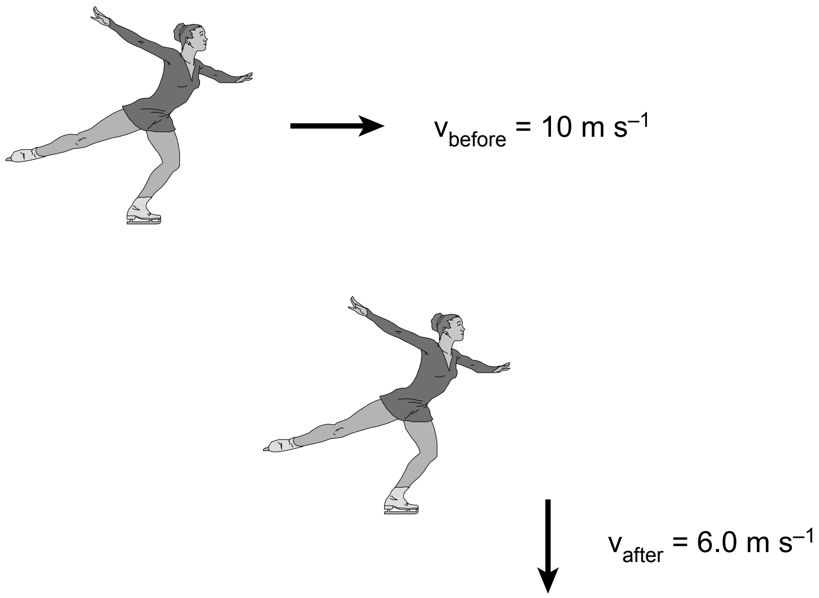
Force =

(iv) Explain the physics involved in finding the answer to (iii).

QUESTION FOUR: SCHOOL TRIP – ICE SKATING

Assessor's use only

Ana is warming up on the ice. She skates in a straight line at a speed of 10 m s^{-1} and then she changes her speed to skate at a speed of 6.0 m s^{-1} at right angles to her original direction, as shown in the diagram below.

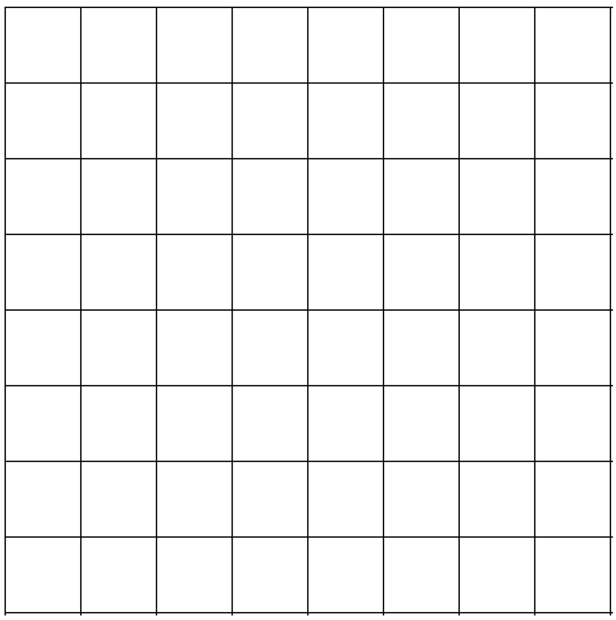


(a) On the grid below, and using the scale given, draw **labelled arrows** to show

(i) Ana's initial velocity

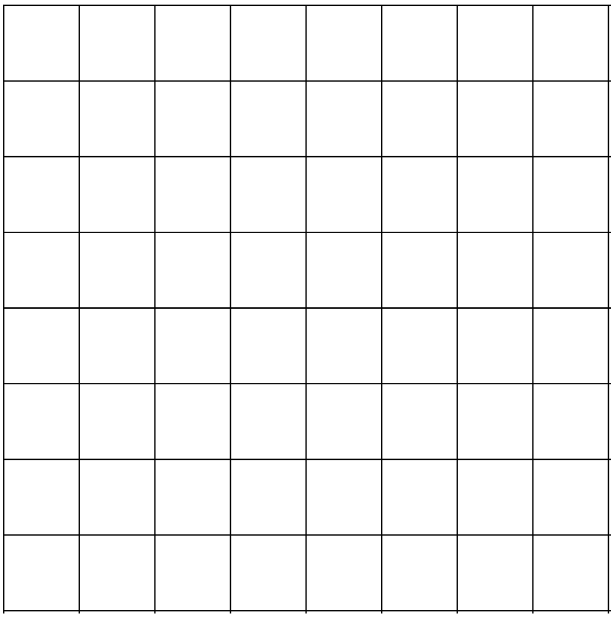
(ii) Ana's final velocity

Scale: 1 square = 2 m s^{-1}



(b) On the grid below, draw a vector diagram to show the **change** in Ana's velocity.

Scale: 1 square = 2 m s^{-1}

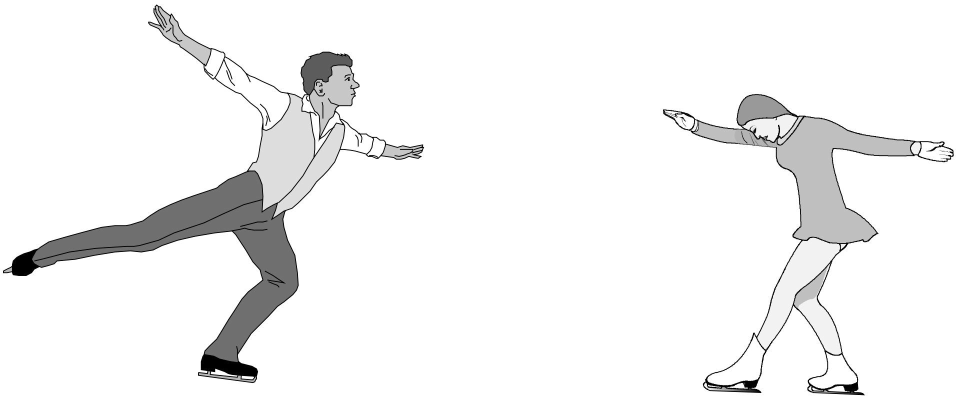


Use your vector diagram to calculate the size and the direction of the change in Ana's velocity. Show clearly on your diagram which angle you have calculated.

(i) Speed = ______________________________

(ii) Direction = ______________________________

Ana and Jon are now practising ice skating routines. Jon (mass 75 kg) skates at 6.0 m s^{-1} towards Ana (mass 55 kg) who is standing still on the frictionless ice. Jon collides with Ana and they move off together in the same straight line that Jon was moving before the collision.



(c) Calculate the speed of the skaters after the collision.

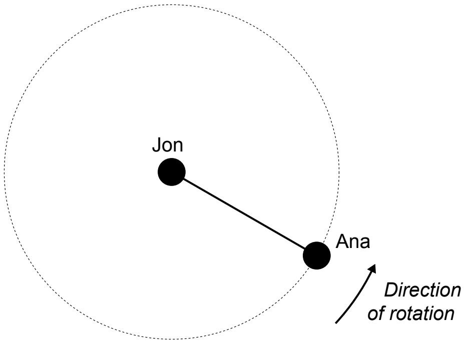
Speed =

(d) Explain the physics involved in finding the answer to (c), including a statement of any assumption made.

Assessor's use only

In another skating move, Jon spins Ana around in a horizontal circle.

You may assume that Ana moves in a circle as shown below.



(e) Draw an arrow on the diagram to show the direction of the tension force that Jon's arm exerts on Ana at the instant shown.

(f) If the radius of the circle is 0.95 m and the tension force in Jon's arm is 5.00 x 10^2 N, calculate the speed with which Ana is travelling around the circle. Give your answer to the correct number of **significant figures**.

Speed = ____________________

Assessor's use only

(g) While Ana is still moving in a circle on the ice, Jon lets her go.

(i) Describe her velocity (speed and direction) after he releases her.

(ii) Explain why Ana travels with this velocity.

Extra paper for continuation of answers if required.
Clearly number the question.

Question number

Assessor's use only