OXFORD

INTERNATIONAL AQA EXAMINATIONS

Topic Test: OxfordAQA International AS level Physics

Mechanics and Materials

Name: _____

Class: _____

Date: _____

Time: **50 minutes**

Marks: **39 marks**

Comments:

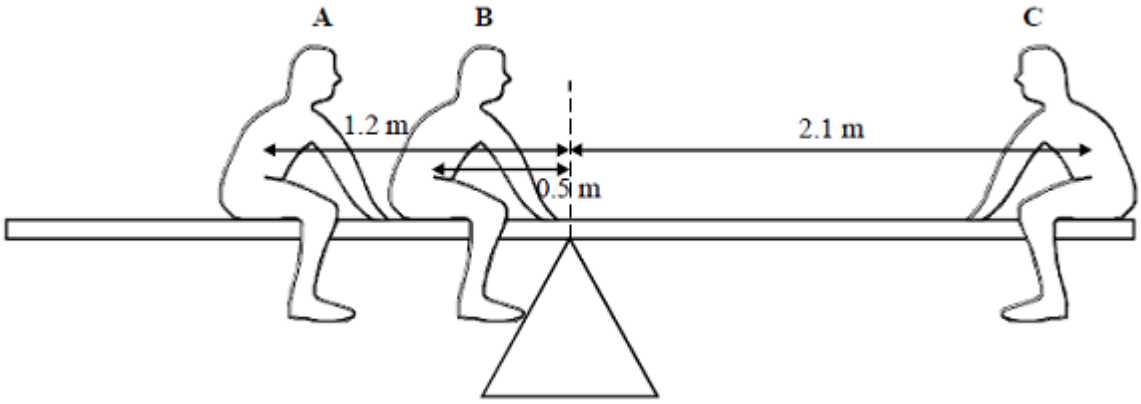
1 The table below indicates some positions of a person carrying out a bungee jump from a high bridge.
Tick the appropriate box(es) to show the forms that the jumper's energy takes at the different stages of the jump.

Energy forms / Position	kinetic energy	gravitational potential energy	elastic potential energy
at the instant the jumper steps off the bridge			
at the instant the elastic bungee rope just becomes taut			
at the instant the jumper reaches the lowest point of the jump			

(Total 3 marks)

2 The diagram below shows three children **A**, **B** and **C** sitting on a balanced, horizontal see-saw of mass 35 kg. The centre of mass of the see-saw is vertically above the pivot.

A has a weight of 650 N and **B** has a weight of 550 N. **A** sits 1.2 m from the pivot and **B** sits 0.5 m from the pivot of the see-saw.



(a) **C** sits 2.1 m from the pivot.

By taking moments about a suitable point, calculate the weight of **C**.

Weight of **C** _____

(3)

(b) Calculate the force on the pivot of the see-saw.

gravitational field strength of Earth, g = 9.8 N kg^{-1}

Force on pivot _____

(2)

(Total 5 marks)

3 A cricket ball is travelling at a speed of 32.5 ms^{-1} when it is hit by a bat. After impact, the ball has the same speed but is travelling in the opposite direction.
The mass of the ball is 0.156 kg.

(a) Calculate the change in momentum of the cricket ball. State an appropriate unit for your answer.

change in momentum _____

unit _____

(3)

(b) The bat is in contact with the ball for 3.80 ms.
Calculate the force exerted by the bat on the ball.

force _____N

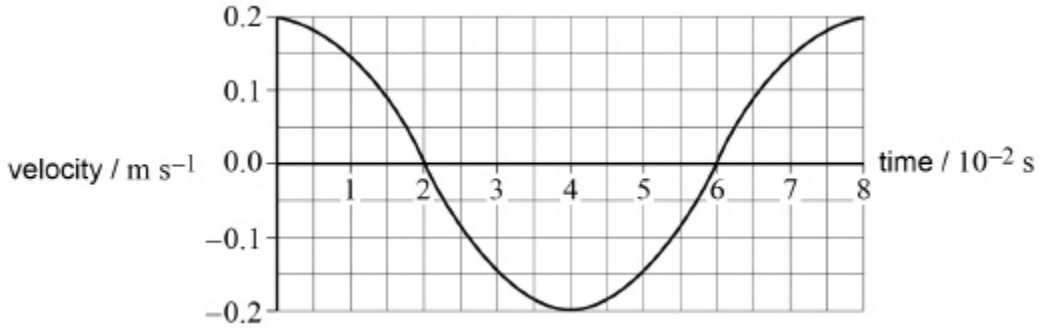
(2)

(Total 5 marks)

4 **Figure 1** and **Figure 2** are identical velocity–time graphs for an object oscillating about a fixed point.

(a) Determine using **Figure 1** the maximum acceleration of the oscillating object.

Figure 1

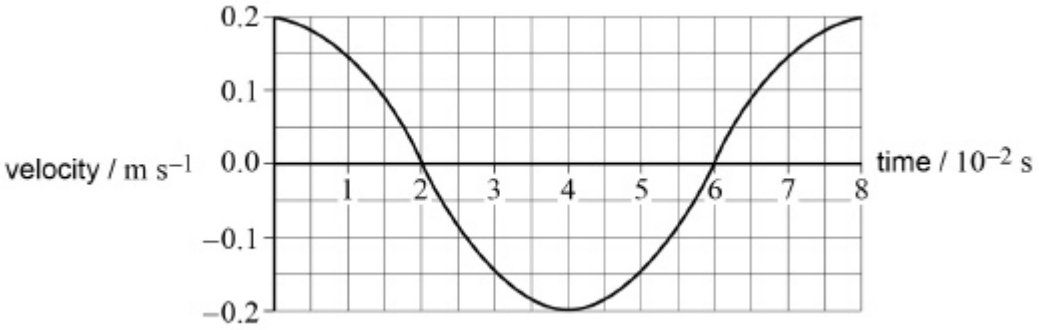


maximum acceleration = _____ m s^{-2}

(3)

(b) Determine using **Figure 2** the maximum displacement of the object from the fixed point.

Figure 2

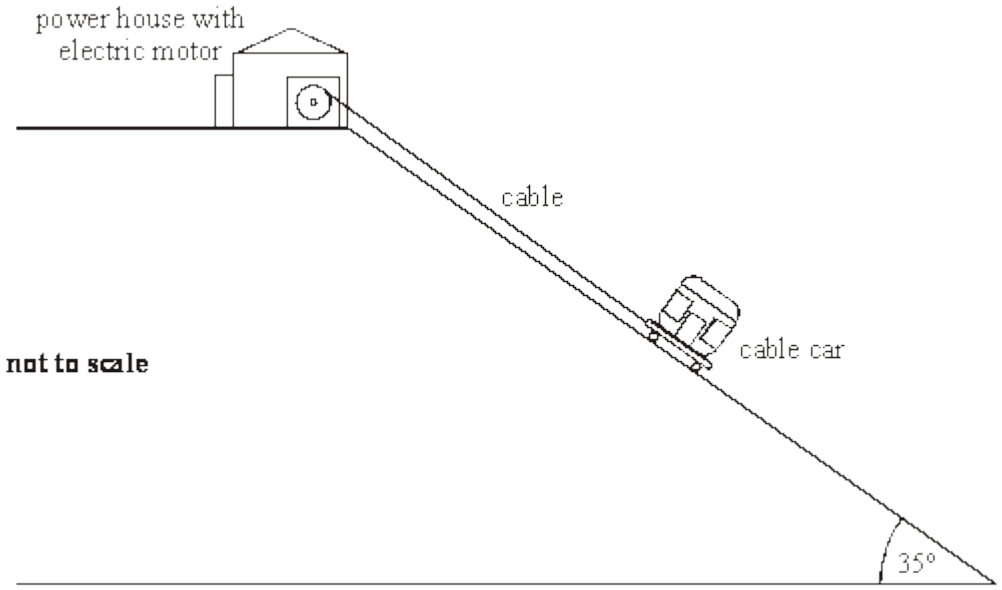


maximum displacement = _____ m

(3)

(Total 6 marks)

5 The figure below shows a cable car being pulled up a 35° slope of length 120 m.



The cable car has a weight of 1.5×10^4 N. The total frictional force resisting motion is 3.0×10^3 N.

the gravitational field strength, $g = 9.8$ N kg^{-1}

(a) (i) Show that the component of the weight of the cable car parallel to the slope is 8600 N.

(1)

(ii) Calculate the tension in the cable when the cable car is moving at a constant speed up the slope.

tension _____

(1)

(b) The cable snaps when the cable car is at rest at the top of the slope. The frictional force remains constant at 3.0×10^3 N.

Calculate:

(i) the acceleration of the cable car down the slope;

acceleration _____

(3)

(ii) the speed of the cable car when it reaches the bottom of the slope;

speed _____

(2)

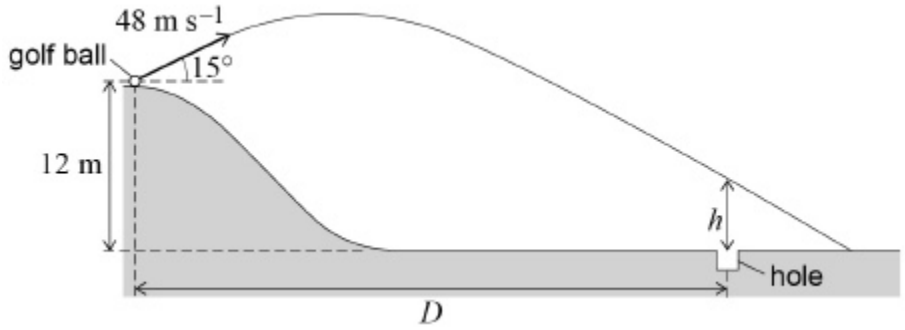
(iii) the time taken for the cable car to reach the bottom of the slope.

time taken _____

(2)

(Total 9 marks)

6 The diagram shows a golf ball hit from a mound of height 12 m.



The initial velocity of the ball is 48 m s^{-1} at 15° to the horizontal.
The golf ball takes 3.0 s to reach a position at vertical height h above the hole.
D is the horizontal distance from the point where the ball is hit to the hole.
Ignore the effects of air resistance for this question.

(a) Calculate D.

D = _____ m

(2)

(b) Show that the initial vertical component of the ball is approximately 12 m s^{-1}.

(1)

(c) Calculate h.

h = _____ m

(3)

(Total 6 marks)

7 What does the area under a force–displacement graph represent?

A acceleration ⬭

B energy transferred ⬭

C impulse ⬭

D spring constant ⬭

(Total 1 mark)

8 A motor is 40% efficient and produces 96 W of useful output power.

What is the energy input to the motor in 2 minutes?

A 240 J ⬭

B 480 J ⬭

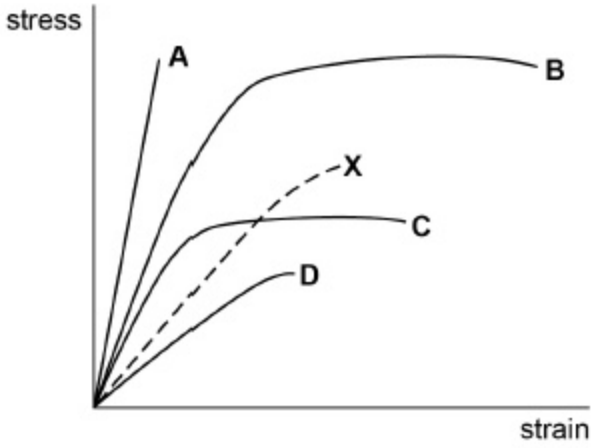
C 4600 J ⬭

D 29 000 J ⬭

(Total 1 mark)

9 Two metal specimens **X** and **Y** are stretched until they break. **Y** has a greater Young modulus, a greater ultimate tensile stress, and is less brittle than **X**. The stress−strain curve for **X** is shown.

Which is the stress−strain curve for **Y**?



A ⬭

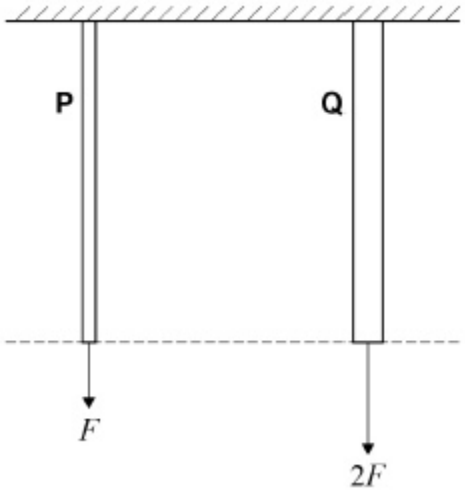
B ⬭

C ⬭

D ⬭

(Total 1 mark)

10 Two wires, **P** and **Q**, have the same original length. They are stretched so that they have the same extensions.



The tensile force in **P** is F and the tensile force in **Q** is $2F$.
P has a diameter d and **Q** has a diameter $2d$.
P is made from a material of Young modulus E.

What is the Young modulus of the material from which **Q** is made?

A $\frac{E}{4}$ ⬭

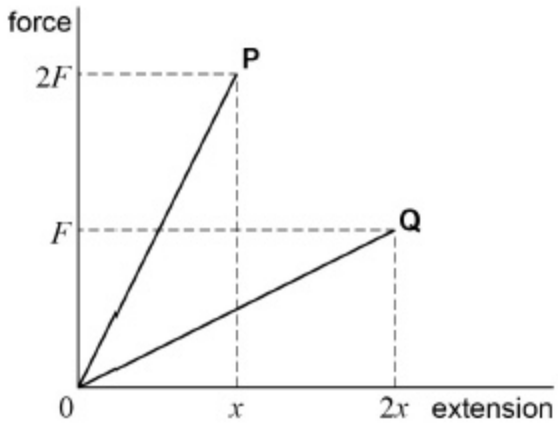
B $\frac{E}{2}$ ⬭

C E ⬭

D $2E$ ⬭

(Total 1 marks)

11 The graph shows the variation of force with extension for two springs, **P** and **Q**.
The energy stored in spring **P** is E and the spring constant of **P** is k.



What are the energy stored and the spring constant for spring **Q**?

	Energy stored in **Q**	Spring constant of **Q**	
A	$\frac{E}{2}$	$2k$	⬭
B	E	$\frac{k}{4}$	⬭
C	E	$2k$	⬭
D	$2E$	$\frac{k}{4}$	⬭

(Total 1 marks)

1 correct boxes ticked

gravitational potential energy **(1)**

B1

potential energy **and** kinetic energy **(1)**

B1

elastic potential energy (in 'rope') **(1)**
(condone gravitational PE in addition)

B1

[3]

2 (a) Use of moment formula

Cl

0.5 × 550 + 1.2 × 650 = Weight C × 2.1

Cl

Weight C = 502 N

Al

(b) Weight of see-saw = 9.8 × 35 = 343 N **or** total people *wt* = 1200 + C
ecf

Bl

Total weight = 2.05 kN

Bl

[5]

3 (a) 32.5 × 0.156 **or** 65 × 0.156: any mass × velocity

C1

10.07/10.1/10 ignore sf

A1

kg ms^{-1} (accept Ns)

B1

3

(b) their a/3.80 (× 10^{-3}) ignore power of 10 error

C1

2670 (N) **ecf**

A1

2

[5]

4 (a) Draws gradient as a tangent to the curve on the graph ✓

Candidates who use a small triangle can access the second and third marks only.

Extracts at least one piece of data from the graph that is used to find a gradient or the gradient of a chord (condoning powers of ten) ✓

Candidates who use 2 widely spaced points on the curve can access the 2nd mark only

15 to 20 m s^{-2} ✓

3

(b) Evidence of determining the area under the graph ✓

Stated or seen on the graph

1 square is equivalent to 2.5 × 10^{-4} (m) **OR** 9 to 11 squares ✓

2.3 × 10^{-3} to 2.7 × 10^{-3} (m) ✓

3

[6]

5 (a) (i) 1.5 × 10^4 sin 35 or 1.5 × 10^4 cos 55 seen = 8603.65 (to 4 sf minimum-no up)

B1

1

(ii) 11 600 N or 12 000 N

B1

1

(b) (i) any 2 from the following for C marks

accelerating force = 5600 N

C1

mass of cable car = 1530 kg (or 15 000/9.8 seen)

C1

F = ma

3.7 m s^{-2} (cnao)

A1

3

(ii) $v^2 = u^2 + 2as$

C1

30 (29.6) m s^{-1} (ecf for acceleration $\sqrt{240 \times acc}$)

A1

2

(iii) any equation of uniformly accelerated motion that includes *t*

C1

8.1 s (ecf for *v* or *a)*
(correct substitution leading to answer = their *v/a* or 240/their *v)*

A1

2

[9]

6 (a) (Horizontal *u* =) 48cos 15 seen (= 46.4 m s^{-1}) ✓

(D = *u*cos15 × *t* = 46.4 × 3.0 =) 139 (m) ✓

Accept 138 m if 46 m s^{-1} is used.

2

(b) 48sin 15 leading to 12.4 m s^{-1}

Must be given to at least 3sf

1

(c) Use of $s = ut + \frac{1}{2}at^2$

(e.g. $(12.4 \times 3.0) + 0.5 \times (-)9.8 \times 3.0^2$) ✓

Allow methods that involve a combination of the other suvat equations

$= -6.9$ m ✓

height h = (12 − their 6.9) = 5.1 m ✓

Accept any clear correct alternative use of the uniform acceleration equations

3

[6]

7 B

[1]

8 D

[1]

9 B

[1]

10 B

[1]

11 B

[1]