Paper Reference(s)

6677

Edexcel GCE

Mechanics M1
(New Syllabus)
Advanced/Advanced Subsidiary
Thursday 7 June 2001 – Afternoon
Time: 1 hour 30 minutes

Materials required for examination	**Items included with question papers**
Answer Book (AB16)	Nil
Mathematical Formulae (Lilac)	
Graph Paper (ASG2)	

Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration. Thus candidates may NOT use calculators such as the Texas Instruments TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G

Instructions to Candidates

In the boxes on the answer book, write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Mechanics M1), the paper reference (6677), your surname, other name and signature.
Whenever a numerical value of g is required, take g = 9.8 m s^{-2}.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
This paper has seven questions.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

1. Two small balls A and B have masses 0.5 kg and 0.2 kg respectively. They are moving towards each other in opposite directions on a smooth horizontal table when they collide directly. Immediately before the collision, the speed of A is 3 m s^{-1} and the speed of B is 2 m s^{-1}. The speed of A immediately after the collision is 1.5 m s^{-1}. The direction of the motion of A is unchanged as a result of the collision.

By modelling the balls as particles, find

(*a*) the speed of B immediately after the collision,

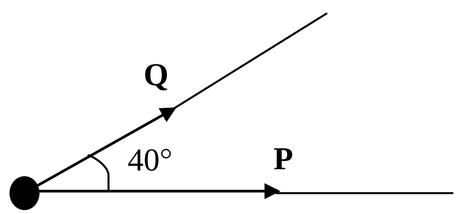
(3)

(*b*) the magnitude of the impulse exerted on B in the collision.

(3)

---

2. **Figure 1**



Two forces **P** and **Q**, act on a particle. The force **P** has magnitude 5 N and the force **Q** has magnitude 3 N. The angle between the directions of **P** and **Q** is 40°, as shown in Fig. 1. The resultant of **P** and **Q** is **F**.

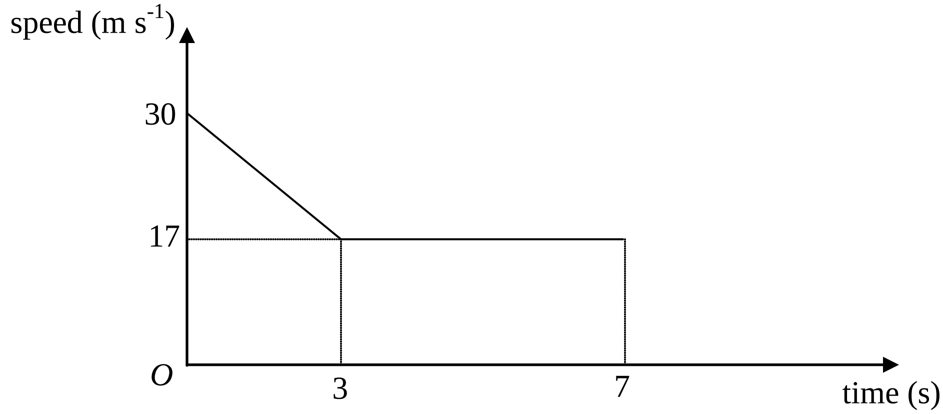
(*a*) Find, to 3 significant figures, the magnitude of **F**. **(5)**

(*b*) Find, in degrees to 1 decimal place, the angle between the directions of **F** and **P** .

(3)

---

3. **Figure 2**



A car of mass 1200 kg moves along a straight horizontal road. In order to obey a speed restriction, the brakes of the car are applied for 3 s, reducing the car's speed from 30 m s^{-1} to 17 m s^{-1}. The brakes are then released and the car continues at a constant speed of 17 m s^{-1} for a further 4 s. Figure 2 shows a sketch of the speed-time graph of the car during the 7 s interval. The graph consists of two straight line segments.

(*a*) Find the total distance moved by the car during this 7 s interval.

(4)

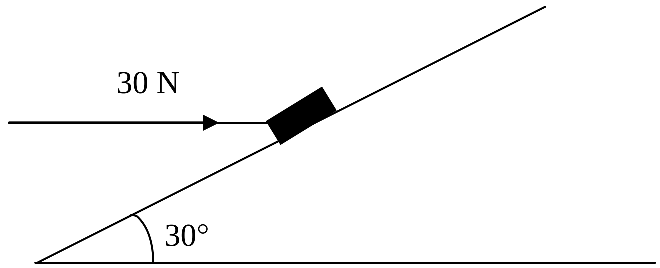
(*b*) Explain briefly how the speed-time graph shows that, when the brakes are applied, the car experiences a constant retarding force.

(2)

(*c*) Find the magnitude of this retarding force.

(3)

4. **Figure 3**



A small parcel of mass 3 kg is held in equilibrium on a rough plane by the action of a horizontal force of magnitude 30 N acting in a vertical plane through a line of greatest slope. The plane is inclined at an angle of 30° to the horizontal, as shown in Fig. 3. The parcel is modelled as a particle. The parcel is on the point of moving *up* the slope.

(*a*) Draw a diagram showing all the forces acting on the parcel.

(2)

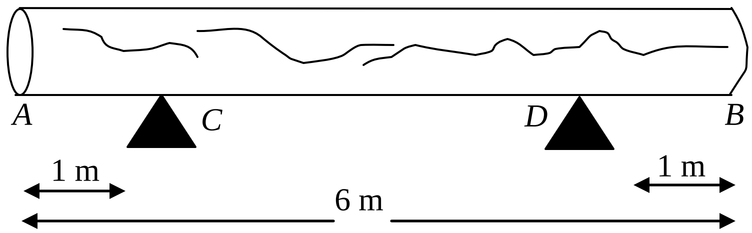
(*b*) Find the normal reaction on the parcel.

(4)

(*c*) Find the coefficient of friction between the parcel and the plane.

(5)

5. **Figure 4**



A large log AB is 6 m long. It rests in a horizontal position on two smooth supports C and D, where AC = 1 m and BD = 1 m, as shown in Figure 4. David needs an estimate of the weight of the log, but the log is too heavy to lift off both supports. When David applies a force of magnitude 1500 N vertically upwards to the log at A, the log is about to tilt about D.

(*a*) State the value of the reaction on the log at C for this case.

(1)

David initially models the log as uniform rod. Using this model,

(*b*) estimate the weight of the log

(3)

The shape of the log convinces David that his initial modelling assumption is too simple. He removes the force at A and applies a force acting vertically upwards at B. He finds that the log is about to tilt about C when this force has magnitude 1000 N. David now models the log as a non-uniform rod, with the distance of the centre of mass of the log from C as x metres. Using this model, find

(*c*) a new estimate for the weight of the log,

(6)

(*d*) the value of x.

(2)

(*e*) State how you have used the modeling assumption that the log is a rod.

(1)

6. A breakdown van of mass 2000 kg is towing a car of mass 1200 kg along a straight horizontal road. The two vehicles are joined by a tow bar which remains parallel to the road. The van and the car experience constant resistances to motion of magnitudes 800 N and 240 N respectively. There is a constant driving force acting on the van of 2320 N. Find

(*a*) the magnitude of the acceleration of the van and the car,

(3)

(*b*) the tension in the tow bar.

(4)

The two vehicles come to a hill inclined at an angle α to the horizontal, where $\sin \alpha = \frac{1}{20}$. The driving force and the resistances to the motion are unchanged.

(*c*) Find the magnitude of the acceleration of the van and the car as they move up the hill and state whether their speed increases or decreases.

(6)

7. [*In this question, the horizontal unit vectors* **i** *and* **j** *are directed due east and north respectively*]

A mountain rescue post *O* receives a distress call via a mobile phone from a walker who has broken a leg and cannot move. The walker says he is by a pipeline and he can also see a radio mast which he believes to be south-west of him. The pipeline is known to run north-south for a long distance through the point with position vector 6**i** km, relative to *O*. The radio mast is known to be at the point with position vector 2**j** km, relative to *O*.

(*a*) Using the information supplied by the walker, write down his position vector in the form (a**i** + b**j**).

(2)

The rescue party moves at a horizontal speed of 5 km h^{-1}. The leader of the party wants to give the walker and idea of how long it will take to for the rescue party to arrive.

(*b*) Calculate how long it will take for the rescue party to reach the walker's estimated position.

(3)

The rescue party sets out and walks straight towards the walker's estimated position at a constant horizontal speed of 5 km h^{-1}. After the party has travelled for one hour, the walker rings again. He is very apologetic and says that he now realises that the radio mask is in fact *north*-west of his position

(*c*) Find the position vector of the walker.

(3)

(*d*) Find in degrees to one decimal place, the bearing on which the rescue party should now travel in order to reach the walker directly.

(7)

END