RESULTANT FORCE

1 Fig. 3.1 shows an aeroplane of mass 3.4×10^5 kg accelerating uniformly from rest along a runway.

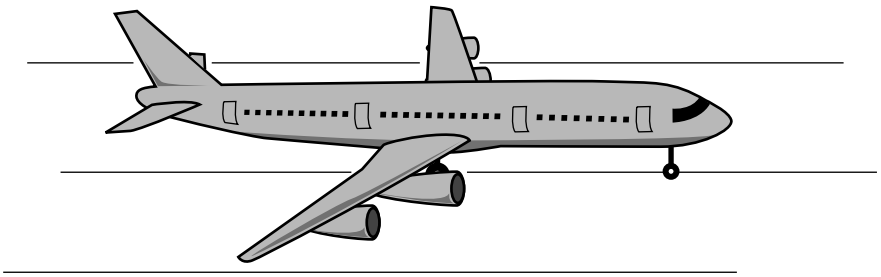

Fig. 3.1

After 26 s it reaches a speed of 65 m / s.

(a) Calculate

(i) the acceleration of the aeroplane,

acceleration = ... [2]

(ii) the resultant force on the aeroplane.

force = ... [2]

(b) Just after taking off, the aeroplane continues to accelerate as it gains height.

(i) State **two** forms of energy that increase during this time.

1. .....

2. ..... [2]

(ii) State **one** form of energy that decreases during this time.

..... [1]

(iii) State why the total energy of the aeroplane decreases during this time.

.....

..... [1]

(c) When the aeroplane reaches its maximum height, it starts to follow a curved path at a constant speed.

State the direction of the resultant force on the aeroplane.

..... [1]

MARKING SCHEME:

(a)	**(i)**	(a =) v/t **or** 65/26		C1	
		2.5 m/s^2 *Unit penalty applies		A1	
	(ii)	(F =)ma **or** 3.4 × 10^5 × 2.5	ecf from **3(a)(i)**	C1	
		8.5 × 10^5 N *Unit penalty applies	ecf from **3(a)(i)**	A1	
(b)	**(i)**	any <u>two</u> of: KE **or** GPE **or** heat/internal energy/thermal energy		B2	
	(ii)	chemical energy **not** heat		B1	
	(iii)	thermal energy/sound is lost (to the atmosphere) **or** KE <u>of air</u>		B1	
(c)		perpendicular to path **or** towards centre of circle **or** centripetal		B1	**[9]**

*Apply unit penalty once only

2 Fig. 2.1 is a head-on view of an airliner flying at constant speed in a circular horizontal path. The centre of the circle is to the left of the diagram.

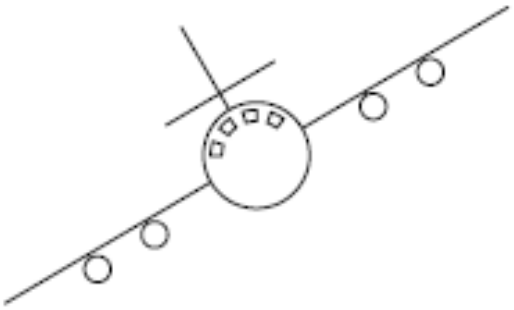

Fig. 2.1

(a) On Fig. 2.1, draw the resultant force acting on the airliner. Explain your answer.

.....

.....

..... [3]

(b) The weight of the airliner is 1.20×10^6 N and there is an aerodynamic lift force of 1.39×10^6 N acting at 30° to the left of the vertical.

By drawing a scale vector diagram, or otherwise, show that the resultant of these two forces is in the same direction as the resultant force you drew in (a).

(i) The speed is constant as the airliner flies in this circular path.

State and explain what is happening to the velocity.

.....

.....

.....

..... [2]

[Total: 8]

MARKING SCHEME

(a)	horizontal by eye	M1		
	arrow to left	A1		
	idea of airliner accelerating/changing direction AND caused by force in that direction o.w.t.t.e. OR centripetal force OR force/acceleration towards centre of circle	B1		[3]
(b)	2 lines approximately length ratio 1.16:1 at 30°/150° to each other	M1		
	parallelogram with line across short diagonal/triangle with original lines at 30°	M1		
	resultant to the left, horizontal by eye	A1		[3]
	for first two marks ignore arrows, ignore labels unless they clarify an otherwise confusing diagram			
	calculation route			
	both forces used in cosine rule	(M1)		
	3rd force from previous line and correct angle used in sine rule	(M1)		
	calculation shows horizontal resultant	(A1)		
(c)	direction changing	B1		
	(therefore) velocity changing or speed/magnitude constant	B1		[2]

3 An object of weight W is suspended by two ropes from a beam, as shown in Fig. 1.1.

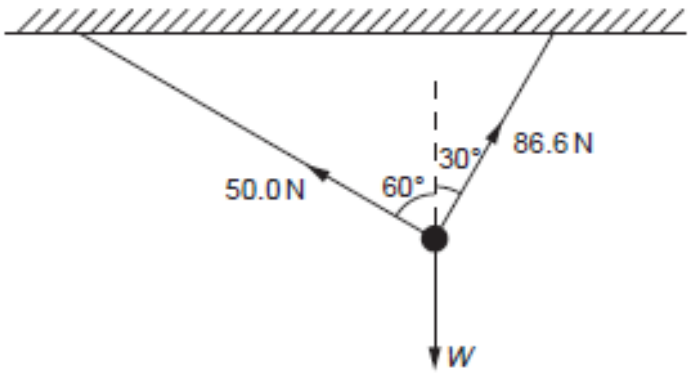

Fig. 1.1

The tensions in the ropes are 50.0 N and 86.6 N, as shown.

(a) In the space below, draw a scale diagram to find the resultant of the two tensions.

Use a scale of 1.0 cm = 10 N.

Clearly label the resultant. [3]

(b) From your diagram, find the value of the resultant.

resultant = ... [1]

(c) State the direction in which the resultant is acting.

..... [1]

(d) State the value of W. W = ... [1]

[Total: 6]

MARKING SCHEME:

(a) (parallelogram or triangle may have any orientation)
NOT a copy of Fig. 1.1
two sides at right angles, by eye — B1
one side longer than the other — B1
diagonal or completion of triangle drawn **and** labelled "resultant" OR R
Ignore numerical values. Condone arrows in wrong direction — B1

(b) 98 N – 102 N — B1
(accept value found by calculation)

(c) (vertically) up/opposite to W NOT North — B1

(d) his **(b)** OR correct value calculated — B1
ignore mass

[Total: 6]

4 Fig. 4.1 shows a heavy ball B of weight *W* suspended from a fixed beam by two ropes P and Q.

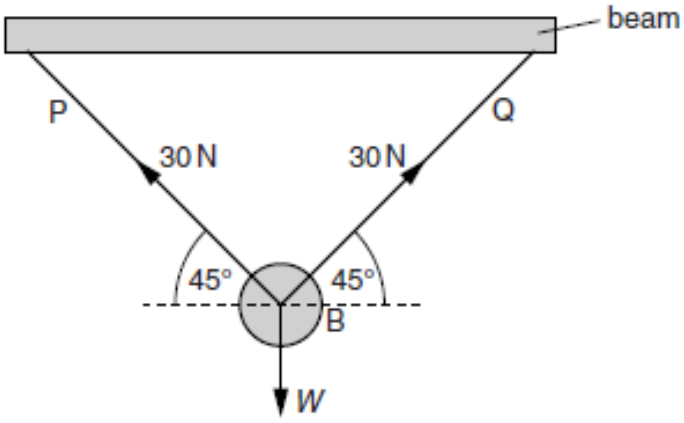

Fig. 4.1

P and Q are both at an angle of 45° to the horizontal. The tensions in P and Q are each 30 N.

(a) In the space below, draw a scale diagram to find the resultant of the tensions in P and Q. Use a scale of 1.0 cm to represent 5.0 N. Label the forces and show their directions with arrows.

resultant = ... [4]

(b) State the direction of the resultant. ..... [1]

(c) State the magnitude of *W*. magnitude of *W* = ... [1]

[Total: 6]

MARKING SCHEME:

(a)	2 lines at 90° to each other of same length labelled 30 N or 6 cm	B1
	both lines 6.0 ± 0.2 cm.	B1
	arrows on the two lines drawn, either head to tail OR a complete square shown with diagonal and arrows on adjacent sides	B1
	resultant in range 40–45 N	B1
(b)	(vertically) upwards	B1
(c)	same as value in **(a)**, only if answer to **(a)** is a force OR 40–45 N	B1

[Total: 6]

5 (a) State the factors which completely describe a vector quantity.

.....

..... [1]

(b) An aeroplane is flying towards the east in still air at 92 m/s. A wind starts to blow at 24 m/s towards the north.

Draw a vector diagram to find the resultant velocity of the aeroplane. Use a scale of 1.0 cm = 10 m/s.

resultant speed = ...

angle between resultant and easterly direction = ...

[5]

[Total: 6]

MARKING SCHEME:

(a)	Size / magnitude (NOT distance) and direction	B1	
(b)	Vectors towards East and North with arrows correct by eye	B1	
	Complete triangle or rectangle for candidate's vectors	B1	
	Resultant with correct arrow	B1	
	Resultant 94 to 96 m/s by scale OR 95 m/s by calculation *Unit penalty applies	B1	
	Angle measured 13.5° – 15.5° OR 15° by calculation *Unit penalty applies	B1	**[6]**

*Apply unit penalty once only

6 **(a)** **(i)** State the difference between a scalar quantity and a vector quantity.

.....

.....

(ii) State one example of a vector quantity.

.....

[2]

(b) Fig. 3.1 shows the top of a flagpole.

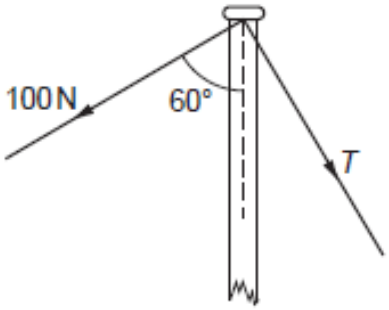

Fig. 3.1

The flagpole is held vertical by two ropes. The first of these ropes has a tension in it of 100 N and is at an angle of 60° to the flagpole. The other rope has a tension T, as shown.

The resultant force is down the pole and of magnitude 200 N.

In the space below, using a scale of 1 cm = 20 N, draw a scale drawing to find the value of the tension T. Clearly label 100 N, 200 N and T on your drawing.

tension T = ...[3]

[Total: 5]

MARKING SCHEME:

(a)	**(i)**	vector has direction OR scalar has no direction/only has size	B1
	(ii)	any appropriate example	B1
(b)		NOTE: accept diagram in any orientation; triangle or rectangle with hypotenuse/diagonal of length ½ that of one side	B1
		100, 200 and *T* all correctly labelled	B1
		value in range 165 N – 180 N inclusive	B1 [5]